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How Are Fruits of Research in Universities and Public Research Institutes Used?
: Brief Overview of the GRIPS Firm Survey

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1. Introduction

One of the roles in research and development by universities and public research institutes is that they conduct the research activities that private enterprises cannot. Under the market mechanism, basic research seems particularly undersupplied as it has the characteristic of public goods. Therefore, universities and public research institutes play a big role in the area of basic research. In addition, basic research has a wide range of applicability; for this reason, if companies develop technology or products by using the scientific knowledge produced by basic research, society can also benefit from the research. From this point of view, it is a policy issue to think of ways to make companies utilize the fruits of basic research conducted by universities and public research institutes. Accordingly, it is important to analyze how research outcomes of universities and public research institutes are used by companies based on data, as well as to analyze how much potential the fruits of research benefit society from the standpoint of designing effective policy.

However, it is not easy to show how research outcomes of universities and public research institutes are used in companies based on quantitative data. Therefore, it is difficult to retroact accurately how a fruit of basic research came to be used in society. In addition, it takes a long time before outcomes of basic research contribute to society. Also, sometimes it is not certain, which fruit of research is linked to which technology or product.[1]

For unveiling how research outcomes of universities and public research institutes are used in companies, one method we can think of, is to ask companies directly through a questionnaire survey. In this method, the data will be subjective in nature.

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[1] An example is the case of the discovery of green fluorescent protein. Dr.Osamu Shimomura received the Novel Prize in 2008, 30 years after his discovery of the protein, because it is presently used as an important tool for medical research, which he did not intend at the point of his discovery.

There are several surveys on cooperation between industry-university-government, which examine how companies use research outcomes of universities and public research institutes.

Research Institute of Economy, Trade & Industry (that is RIETI, 2003) conducted a large-scale questionnaire survey and its target is to survey 7,442 firms that were also the targets of a survey called "Basic Survey of Japanese Business Structure and Activities"[2] conducted by the Ministry of Economy, Trade and Industry. They were separated from the other firms based on the fact that they are doing their own research and development. Among the 7,442 firms, the number of the firms that returned an effective answer were 802. The result of this survey gives us various types of quantitative information. However, in this survey among the 802 firms that returned an effective answer, the sample is skewed to manufacturing industry (694 firms belong to the industry. This is 86.5% of the entire sample). Another point to be made is that this is desigend for the survey targets of "Basic Survey of Japanese Business Structure and Activities." To begin with, the targets are the enterprises in manufacturing and wholesale industries with 50 or more employees and capital of over 30 million yen. Therefore, we cannot deny that the sample tends to be skewed to firms having certain level of size.[3]

"Survey report on research and development of private enterprises" by The Ministry of Education, Culture, Sports, Science and Technology (MEXT, 2007) is a survey targeting 1,791 private enterprises for their research activities. The number of the enterprises that gave effective answers were 896. The rate of effective answers were 50.0%. However, the target of the survey is the private enterprises with capital of more than 1 billion yen that responded to the survey conducted by the Ministry of Internal Affairs and Communications (MIC) for "Report on the Survey of Research and Development in Japan" in 2005 and showed that they are doing research and

[2] In terms of the "Basic Survey of Japanese Business Structures and Activities," Matsuura and Kiyota (2004) conducted verification of the characteristic of the data in the process of verifying the answers that were made into the panel data.

[3] If we compare "Basic Survey of Japanese Business Structures and Activities" to previous survey in which firms are selected using the financial statements, the targets are not skewed to listed companies. Also, the range of industries included in the survey target is wide. The survey targets of many statistics released from countries throughout the world are mainly manufacturing companies. There are almost no statistics, which cover non-manufacturing industries. In contrast, "Basic Survey of Japanese Business Structures and Activities" includes non-manufacturing industries as well. For this reason it is said that "Basic Survey of Japanese Business Structures and Activities" is one of the foremost business statistics in the world (Matsuura and Kiyota, 2004). However, as stated above, the target of "Basic Survey of Japanese Business Structures and Activities" is restricted to firms that belong to the manufacturing or wholesale industry with more than 50 employees and with a capital of more than 30 million yen. As long as these conditions exist, we cannot deny that the statistics are skewed to firms with a certain level of size and certain industries.

development activities by themselves. The characteristic of this survey is dominance of large enterprises. In addition, among 896 enterprises who returned effective answers, 734 enterprises belong to the manufacturing industry. Thus, this survey is also skewed to the manufacturing industry (81.9% of the whole sample). Apart from the surveys already stated, the Small and Medium Enterprise Agency (2008) is also conducting a survey on cooperation between industry-university-government; however, the target is limited to small and medium enterprises.[4]

The statistics cited above are all official statistics. However, there are also surveys done by researchers who conducted them with thier original questionnaires. One of such surveys was performed by Okamuro (2006a,b), who conducted a "Questionnaire survey on joint research and development and on university-industry collaborations" and is investigating the real status of cooperation between industy-university (the survey target: 10,579 enterprises, the number of effective answers: 1,857, the rate of effective answers: 17.6%). However, this questionnaire survey focuses on the manufacturing industry. In addition, Okamuro (2009a,b) conducted his own unique survey targeting small and medium enterprises with more than 20 employees, and which are in the three technical fields of biotechnology, microelectronics, and software, with which basic research is closely linked (target of survey: 9,882 enterprises, the number of effective answers: 1,726, the rate of effective answers: 17.5%). We need to note that in the actual analysis the target is focused on the industries closely related to the three technical fields above and on the small and medium enterprises.[5]

As explained in the foregoing, surveys on cooperation between industry-university-government done in the past are equally limited in size for the enterprises regarding the target. In addition, in many cases the sample obtained is skewed to manufacturing industry.

On the other hand, when we look at how enterprises are using research outcomes of universities and public research institutes, we realize that the occasions to use research outcomes are not limited to cooperation between industry-university-government. Academic publications, presentations at academic conferences, and personal communications among researchers are also assumed to be some ways for enterprises to capture the knowledge produced by universities and public research institutes. Therefore, it is necessary to investigate the ways research

[4] According to this survey, small and medium enterprises that are participating in university-industry-government collaborations are 5.2%. It is reported that among them 10.1% of small and medium enterprises that belong to manufacturing industry, participate in cooperation between industry-university-government.

[5] The target of the survey that Okamuro (2009a,b) actually made the target of analysis was small and medium enterprises of less than 300 employees.

outcomes of universities and public research institutes are used in a broader spectrum. Such an investigation would contribute to understand how enterprises utilise the research outcomes of universities and public research institutes that are the public goods.

Considering the situation as we have explained, we conducted a large-scale questionnaire survey. In our survey we included a wide range of industries that were not included in the previous surveys. The number of the targets of our survey amount to 20,000 firms, much broader than those seen in the previous ones, including small firms. The items included in the questionnaire are also varied. We ask firms from various angles about research outcomes of universities and public research institutes. Hereafter we call it "GRIPS firm survey."

Based on this survey, we intend to conduct detailed quantitative analysis on research and development of enterprises utilizing cooperation between industry-university-government. Preceding the detailed analysis, the present text reports the method of survey and the overview of the result.

2. Data

(1) Method of Survey

We made our own survey sheet for this survey. The actual survey was done by the research company Teikoku Databank[6] to whom the National Graduate Institute for Policy Studies and Office of Economic and Industrial Research in House of Representatives entrusted the survey. Specifically, our survey was carried out together with "TDB Survey of Business Trends," which Teikoku Databank has been conducting every month. The survey method is online submission over the Internet. As for the target companies of the survey, the companies that agreed to cooperate with the survey were the targets. The targets include all types of industries in Japan. The survey period is 20 days from December 17, 2008 to January 5, 2009.

The research company makes the survey request to the target companies by e-mail along with a URL that they will need to access. The person receives the e-mail and answers online and then sends the answer. All the questions are presented at once. The respondents can change answers by returning to the questions that they have once answered. It should also be noted that the participant can leave a particular question unanswered. The survey request is sent to the headquarters of each firm, and the

[6] Teikoku Databank http://www.tdb.co.jp/
As for the details of Teikoku Databank "TDB Survey of Business Trends," refer to the following HP. http://www.tdb-di.com/visitors/keiki_report/pdf/about_keiki.pdf (The date the site was checked: March 4, 2009.)

department is not specified. Fifty percent of the respondents are on the management layer. The respondents who are not on the management layer are asked to reply as a firm, not as an individual.[7]

In this survey, we requested responses for 20,455 firms and obtained effective answers from 10,731 firms. The rate of answer is 52.5%. The strength of "TDB Survey of Business Trends" is that the number of target firms is unparalleled in its numerousness, the body of respondents includes firms much broader in categories of business and in size, compared to preceding surveys.

(2) The Basic Profile of the Respondent Firms and the Representativeness of the Data

While we organize the basic profile of the respondent firms in this survey, we will also examine the representativeness of the data by comparing our data to "Establishment and Enterprise Census" (2006)[8] released by the MIC. Every establishment and enterprise is the targets of "Establishment and Enterprise Census" and it surveys the basic matters such as types of business, number of employees etc. It is conducted to gather basic data for administrative measures and policies and to obtain information for population of establishments and enterprises to conduct the various statistical survey. Every establishment and enterprise is the target of "Establishment and Enterprise Census" and this survey is considered to be very effective when we want to confirm the distrubution of firms all over Japan. At the point of the survey that was conducted in 2006, the number of firms in Japan was 1,516,000.

Table 1 shows descriptive statistics that are related to basic attributes of firms participating in our survey.

＜Table 1＞

Apart from the questionnaire items that we designed independently, seven basic attributes were obtained. They are "prefectures" in which the headquarters of each firm are located;[9] "10 areas," which are made by dividing Japan into 10 areas;[10],

[7] A monetary reward is not given to the respondents. The research company instead sends the companies who registered as monitors a white paper on business climate per year; emails with a large scale bankruptcy flash report; columns about business trend analyses written by an TDB excpert via e-mail; and business information through the webpage.

[8] "Establishment and Enterprise Census" (2006) is on the following website of. MIC. http://www.stat.go.jp/data/jigyou/2006/index.htm (The date the authors checked the website: March 4, 2009)

[9] In this survey, the unit of counting is a corporate body. Our questionnaires are sent to the headquarters of firms by mail. Therefore, the activities of business offices that are different from headquarters may not be included. However, the percentage that big corporations occupy in the

"number of employees";[11] "capital (unit: 1,000 yen)";[12] "Big firm dummy" in which companies are classified into category of business according to capital and number of employees of which are based on Small and Medium Enterprise Basic Law, and if the company is a small and medium enterprise, it will take 0, and if the company is a large company, it will take 1. "industry (10 industries)" where the firm falls, and "category of business (51 category of business)," which are subdivision of industry.[13]

At first we will look at our data by area and compare this data with that of the "Establishment and Enterprise Census." When we look at Japan as a whole through the 10 areas, we notice that many of our corporate respondents are located in large metropolitan areas such as Tokyo, Osaka, or Aichi (Figure 1).

<Figure 1>

When we look at "Establishment and Enterprise Census" by the 10 areas (Figure 2), the shape of distribution resembles to that of our data (Figure 1) and the two figures are largely similar.

<Figure 2>

When we look at by prefecture, it is also largely the same (Figure 3, 4).

<Figure 3>

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sample of this text is only 9.8% (Refer to Table 1). About 90% is small and medium enterprises. Therefore, the companies that have business offices, which are different from the headquarters do not seem to be many. In this survey, we ask each respondent to answer as a corporate body. Considering this fact, the answers we obtained seem generally to represent the company to which the respondent belongs.

[10] Specifically, we divided Japan as follows: Hokkaido, Tohoku (Aomori, Iwate, Miyagi, Akita, Yamagata, Fukushima), Kita Kanto (Ibaragi, Tochigi, Gunma, Yamanashi, Nagano), Minami Kanto (Saitama, Chiba, Tokyo, Kanagawa), Hokuriku (Niigata, Toyama, Ishikawa, Fukui), Tokai (Gifu, Shizuoka, Aichi, Mie), Kinki (Shiga, Kyoto, Osaka, Hyogo, Nara, Wakayama), Chugoku (Tottori, Shimane, Okayama, Hiroshima, Yamaguchi), Shikoku (Tokushima, Kagawa, Ehime, Kochi), Kyushu (Fukuoka, Saga, Nagasaki, Kumamoto, Ooita, Miyazaki, Kagoshima, Okinawa).

[11] We considered people who are working who were hired as employees. However, there are some firms in which workers are only executive officers. In such cases, we supposed that the number of employee was made to be 0. There were 47 such firms.

[12] In the data we obtained, there were 24 businesses whose capital was 0. These were family-operated businesses.

[13] We selected categories of businesses, which are needed for analysis using Japan Standard Industrial Classification and Bankruptcy Summary by Teikoku Databank as references. Categories of businesses, which were not selected were classified as "others." In the end, 10 industries (51 categories of business) were created.

< Figure 4>

As shown above, the representative nature of our respondent firms seems high for geographical distribution of firms.

Next, we will look at our data in terms of the number of employees. Here we will look at the distribution of firms in keeping with the classification of the size of employees that is based on the Small and Medium Enterprise Basic Law. Figure. 5 shows that the sample is skewed toward firms with small size of employees. Figure 6 is distribution of firms by size of employees, which was created from "Establishment and Enterprise Census" to compare with our data. However, the data of "Establishment and Enterprise Census" we could use was data on regular employees.[14] On the other hand, the number of employees in our data means the number of permanent employees. In this regard, we should note that the definition of an employee is not the same between "Establishment and Enterprise Census" and our data. On that basis, there are some similarities. Both of "Establishment and Enterprise Census" and our data are skewed to firms with 50 employees or less. In both cases, the more the number of employees increases, the number of firms decreases. However, there are more firms with large size of employees in our data. When we limit the scope to the firms with 50 employees or less, these firms occupy more than 90% in "Establishment and Enterprise Census." In contrast, in the sample from our survey, firms with 50 employees or less is 57%. In this regard, the sample of firms of small size is relatively fewer.

<Figure 5>

<Figure 6>

As stated earlier, whereas employees in our survey mean permanent employees, in "Establishment and Enterprise Census" it means regular employees. Although there is a difference in the definition, Figures. 5 and 6 show that our survey contains firms that are relatively larger in the size of employees compared with those of "Establishment

[14] Specifically, a regular employee is a person who is employed without fixing the period of employment or a person employed after fixing the period of employment that is more than 1 month, or a person employed more than 18 days during the two months preceding the date of survey. In regular employees, those who are not permanent employees, such as part-time workers, moonlighters, and temporary employees, are included. Refer to the following website (Ministry of Internal Affairs and Communications) for this definition of a regular employee.
http://www.stat.go.jp/data/jigyou/2006/yougo18.htm (The date the website was checked: March 6, 2009)

and Enterprise Census." Thus, it is necessary to note on the representative nature in this regard. However, our sample contains firms with 50 employees or less and firms with capital of less than 1 billion yen. Therefore, our survey consists of a broader sample than those of the preceding surveys. Both of the RIETI Survey and the MEXT Survey described in Sec 1. did not contain firms with 50 employees or less and capital of less than 1 billion yen.[15]

Now, we will look at our data focusing on industry. In our data, the number of the firms in wholesale industry were highest. This industry occupies 32% of the whole. The industry that comes in second is manufacturing occupying 29% of the whole and is followed by Service and Building (Figure 7). Next, we examine the percentage of firms by industry in comparison with "Establishment and Enterprise Census." The industrial classification used in "Establishment and Enterprise Census" is not necessarily the same with our industrial classification. We need to be careful on this point. However, in "Establishment and Enterprise Census" the firms in wholesale and retail are highest in number followed by manufacturing, building, and service (Figure 8). Thus, there is not much difference between our data and those of "Establishment and Enterprise Census."

<Figure 7>

<Figure 8>

<Figure 9>

As we have stated earlier, we have to notice that our survey uses the samples in which the size of employees is relatively larger than the "Establishment and Enterprise Census," with regard to the size of enterprises. Therefore, it is necessary to keep in mind that our suvey may not necessarily represent the whole truth. There is also a possibility that the difference between our survey and the "Establishment and Enterprise Census" in terms of the range of employees may be exerting influence. However, comparing with the preceding surveys, our survey seems to have universality. The standpoint of the location of firms and the industry,

[15] The number of firms with less than 50 employees is 6,096.When we look at our survey in terms of employees and in terms of capital, firms whose capital is less than 30 million is 4,636.

the representativeness seems higher compared with "Establishment and Enterprise Census."

Figure 9 shows the percentage of firms who answered on category of business, which were divided into the smaller category from the industrial classification.

3. Brief overview of the result of the simple tabulation and cross analysis

The characteristic of this survey is, as stated above, not only does the survey has the wide range of categories of business and various size of businesses, but also this survey attempts to grasp the use of research outcomes of universities and public research institutes through widening the scope of evaluation without limiting it to usual cooperation between industry-university-government. Furthermore, our approach has multiple points of view such as how businesses are using research outcomes produced by universities and public research institutes and to what extent.

The questionnaire of this survey and descriptive statistics to questions are shown in tables 2 and 3.

＜Table 2＞

＜Table 3＞

In the following, we will look at simple tabulation and a part of the result of cross table analysis based on the simple tabulation.[16]

(1) "Currently do you utilize in-house research and development or external research outcomes in one way or another?" (Question 1)

At the beginning, we asked respondents whether they were using in-house research and development or external research outcomes in one way or another (Question 1) (Figure 10).

<Figure 10>

The number of firms who answered this question is 10,731. The greatest in number is "none"(R&D7) and amounted to 46%. On the other hand, the result suggests

[16] As for the detailed findings of this survey, refer to the cross tabulation table attached at the end.

that firms corresponding to about half of 10,731 are using research outcomes of universities and public research institutes for their business in one way or another.

From several points of view, we will look at the factors that influence internal research and development or introduction of technology. As for the issue of whether research and development or introduction of technology can be actually possible or not may be related to the size of the firm. Therefore, we will look at the relationship of this question with the size of the firm indicated by the number of employees according to the result of the cross table analysis (Figure 11).

<Figure 11>

This result suggests that the larger the size of employees becomes, the more the companies conducting their own research and development or the companies introducing research outcomes from external institutes.[17]

Next, we will look at industries. When we observe industries that are aggressive in research and development or introduction of technology and those are just the opposite, we come to see that generally as for any type of research and developement or introduction of technology, there are similar characteristics by industries (Figure 12). As for comparison of industries seen from the percentage of companies conducting in-house research and development, the companies in manufacturing showed highest percentage to affirmative answers, followed by agriculture, forestry and fisheries, and service.

<Figure 12>

Firms that gave positive answers in Question 1, that is, the firms that answered that they are conducting research and development or they are introducing technology, were invited to answer to the following questions. It is because the questions given after Question 2 cannot be answered logically if the respondent had no prior experience on research and development or introduction of technology. However, there were respondents who did not follow the instruction and answered the subsequent questions, which followed Question 2 notwithstanding that they gave negative answers (g) in Question 1. Therefore, in questions given after Question 2, we targeted only the respondents who answered

[17] However, in this survey, samples of enterprises of small size are relatively less. In interpreting, it is necessary to note how this fact influences the result. This is also applicable to the following analysis by the size of employees.

(a) - (f) in Question 1, and we did data cleaning. Note that the sample fell from 10731 to less than 5360 after question 2 as a result of these actions.

(2) "In which fields do you currently utilize research outcomes of universities and public research institutes?" (Question 2)

In looking the tabulation result (Figure 13), the proportion of the firms that answered that research outcomes of universities and public research institutes "do not help" was 27%. This does mean that more than 70% uses the research outcomes of universities and public research institutes in one way or another. The highest in number for this question was the field of manufacturing technology that occupied about 33%. The companies that use research outcomes in the field of environment were 16 % . The companies that use research outcomes in information and telecommunication were about 11%.

<Figure 13>

It is supposed that the field in which fruits of research and development are used is related to the category of business the firm belongs to. As we showed distribution of the category of business of the respondents (Figure 9) earlier, wholesale was the highest in number followed by manufacturing, service, and building. Regarding the relationship[18] between these categories of business and fields in which research outcomes of universities and public research institutes are used, we will look at the result of cross tabulation analysis (Figure 14).

<Figure 14>

Figure 14 shows percentage of response for each option in Question 2 by setting the number of the companies responded in each industry to 100%. In manufacturing, 44% of the respondents answered that they use research outcomes related to manufacturing technology for their business. However, the percentage of those using manufacturing technology is also higher in the field of agriculture, forestry and

[18] In Shirai and Kodama (1990), the relation between categories of business and field of research was studies. In this study the field of business of the companies participating in each project under the system of research partnership were surveyed and made known that fusion of technology was occurring in such a way that firms dealing with building, fiber, nonferrous metal, metal, and shipbuilding participated in the field of biotechnology; and firms dealing with chemistry, glass, soil and stone, and ferrous metal products participated in the field of electronics.

fisheries as 47%. In the filed of environment, it is highest in building in which 28% of respondents answered that they are using it. As for the field of environment, it is followed by agriculture, forestry and fisheries (24%) and real estate (22%). This fact seems to reflect that the environment-friendly housing and city planning have been demanded in recent years. As for the field of information and telecommunication, in service, transportation and warehousing, and real estate, the proportion of the companies using the technology from each field was equally about 28%. The reason may be that the field of service includes information service and telecommunication. As for transportation and warehousing, it can be thought that IT technology is contributing to product distribution system and logistics.[19] With real estate industry, we can think that information and telecommunication are used[20] for advertising on the Internet and for customer information control system.

As shown above, there are differeces among industries as to what fields of research of universities and public research institutes are actually being used. The result of the cross tabulation analysis made us reconfirm such differences. Some industries have already established their relationship in particular fields of research and development with universities and public research institutes. For the combination of companies and universities in which cooperative relationship has already been established, there will be no need for policy support from the government in forming proper matching of knowledge. On the other hand, for the combination of companies and universities in which cooperative relationship has not been established, it is desirable to promote a new combination between companies and universities, which has a potential to lead innovation. Therefore, policy support is required at the precompetitive stage in which, say, a consortium is formed to investigate the potential of an invention in a particular field by participation of multiple enterprises, universities and public research institutes.

(3) "At which stage of business were research outcomes of universities and public research institutes helpful?" (Question 3)

When we look at the result of tabulation, the respondents who answered "There was nothing to help (process 15)" were 33%. Apart from this answer, the respondents who answered "research outcomes helped business as a complement of development

[19] In each issue of *Monthly Logistics Business*, specific cases related to information technology for product distribution are introduced.
[20] Refer to the following website of The Association for Real Estate Information: http://www.realtor.or.jp/

(process 4)" were 15%; "Useful as a complement of basic research (process 2)" were 14% (Figure 15).

<Figure 15>

In the introduction we stated that universities and public research institutes play an important role in that they supply basic research that tends to be undersupplied under the market mechanism. Therefore, the result that research outcomes were useful as a complement rather than substitute was something we did not expect. In addition, there were such answers that the research outcomes of universities and public research institutes worked as complimentary function like "complement to conception of something new or to project planning (process 3)," "confirmation of effectiveness of technology (process 7)" or "complement to marketing promotion (process 12)." This kind of complementary function is an important implication in considering the most effective way of using research outcomes of universities and public research institutes.

Then, were these way of use influenced by the size of business? We will look at it from the result of cross table analysis in which the size of employees is a proxy of firm size (Figure 16).

<Figure 16>

Concerning "substitutes for basic research (process 1)," "complements for basic research (process 2)," "complements for development (process 4)," "confirmation of the direction of technology development (process 8)," the more the size of employees is, the more companies utilize reeserch outcoms of universities and public research institutes at those stages. As for others, there is no relation between the size of employees and the activities. These suggest that business activities were influenced by the size of the enterprise at some stages at which companies use research outcomes of universities and public research institutes, while,at other stages they were not.

(4) "By which ways do you collaborate with universities or public research institutes during the last 10 years?" (Question 4)

Here, in order to reveal the way of cooperation between companies and universities, we will look at the detailas. Among the alternatives, the percentage of the

companies marking “we have no such experience (collabo 14)” were the highest. The next highest answers were “joint research (collabo 1),” “contract research (collabo 2),” and “contributing fund to universities and public research institutes to support research (collabo 4)” in that order.(Figure 17).

<Figure 17>

As stated in the first section of this paper, many questionnaire surveys on cooperation between industry-university-government have been conducted. Here we compare our survey with that of Motohashi (2005), which is a preceding survey. We followed Motohashi (2005) and divided the size of employees into 4 groups and showed the percentage of firms engaged in cooperation between industry-university-government, by setting the number of firms in each group divided by the size of employees to 100% (Figure 18).

<Figure 18>

As a result, the percentage tended to increase as the size of business increased in joint research (collabo 1), contract research (collabo 2), exchanges between researchers (collabo 3), contributing fund(collabo 4), technology transfer with license contract (collabo 5), and participation in university start-ups (collabo 7). As for joint reserch (collabo 1), contract research (collabo 2), and contributing fund (collabo 4), our study showed approximately the same result as that of Motohashi (2005), a preceding study. Compared with the data that Motohashi (2005) used, our data contains a wider range of industries. In addition, we have smaller size of firms in terms of the number of employees. However, a part of the result Motohashi obtained and a part of our survey shares the similar trait. This may indicate that the firms engaged in cooperation between industry-university-government is limited to those with the size of more than a certain level.

(5) “Which is the percentage of products and services of your company that could not be created without research outcomes of universities and public research institutes?” (Question 5)

The Question 5 was designed according to a question in the preceding studies (Mansfield 1991, 1998). In questionnaire surveys toward companies, Mansfield

(1991, 1998) asked about the percentage of the products that had not been developed without outcomes of basic research, to compare among industries. The percentage of products that had not been created without outcomes of basic research was 15% in the average of all the categories of business. On the other hand, the percentage of pharmaceuticals was 31%, which was higher than the average of all the categories of business. In our survey, we obtained the following result in simple tabulation (Figure 19.)

<Figure 19>

For the percentage of products that could not be created without research outcomes of universities and public research institutes, "Nothing" was the highest (43.4%). The percentage is almost decreasing, to the response to "all" (0.48%). This result suggests that the amount of the products that had not been created without research outcomes of universities and public research institutes were not too much.

As the industrial classification in this survey is different from that of Mansfield (1991,1998), we cannot make a complete comparison. However, we will look at the result of comparison among industries from the cross table analysis.

<Figure 20>

As shown in Figure 20, disparity between some industries is displayed. To compare the percentage of products that had not been produced without research outcomes of universities and public research institutes, we combined the percentatge of responses from "very large" to "more or less." In this condition the industry of agriculture, forestry, and fisheries showed the conspicuously high percentage.[21] As for others, manufacturing and building are also at the high score.

(6) "How long did it take to complete your products or services which you could not produce without research outcomes of universities and public research institutes, after introducing them or starting collaboration with universities and public research institutes?" (Question 6)

It is said that it takes a long time before basic research becomes a concrete product. The Question 6 was made to make respondents reveal this view. The result is shown in

[21] However, in agriculture, forestry, and fishierries, the answers with "all" and "very large" were 0%.

Figure 21.

In observing the result, we should note the following points. If a respondent answered that the percentage of the products that could not be created without research outcomes of universities and public research institutes was “Nothing” in the Question 5, he will not be able to answer to Question 6. However, there were respondents who answered as “Nothing” in Question 5 and yet marked one of the alternatives in Question 6. Therefore, we did data cleaning to eliminate this contradiction of logic. As the result, the sample in Question 6 decreased from 3,446 to 2,674.

<Figure 21>

The answer “2 years or longer and less than 4 years” was the highest in number and amounted to 32.3%. The answer “1 year or longer and less than 2 years” came next and was 31%. The matter of duration leading to completion of a new product is a problem open to interpretation. The duration also depends on the product to develop. However, the result suggests that the duration leading to commercialization of a fruit of research performed in universities and public research institutions is neither extremely long nor short. When research outcomes of universities and public research institutes are used complementarily, it might be possible to shorten the duration leading to commercialization of a product.

(7) “To what percentage of your sales do you think that research outcomes of universities and public research institutes contribute?” (Question 7)

In Question 5 we asked respondents about the extent to which research outcomes of universities and public research institutes were linked to commercialization of products. Here in Question 7 we asked respondents about the extent to which research outcomes of universities and public research institutes contribute to sales of the company. Basically, bringing about commercialization of a product is one thing and contributing to sales is the other. Even if research outcomes lead to commercialization of products, we do not know whether the products are successful in sales or not. It is the matter of markrting strategy of the company, rather than the value of research outcomes.

Therefore, next we will reveal to what extent enterprises consider research outcomes produced by universities and public research institutes contribute to their

sales.

<Figure 22>

As shown in Figure 22, the result was almost the same with that of Question 5. This result suggests that there is not much difference between commercializing research outcomes of universities and public research institutes and bringing about sales of the product. As shown in Figure 23, the result by industries did not differ much from that of Question 5.

<Figure 23>

4. Conclusion

In this paper we outlined the result of our survey on utilization of research outcomes of universities and public research institutes. Specifically, the following matters were revealed.

As for the question on utilization of in-house research and development or introduction of external research outcomes in one way another or on such experience in the past, approximately half of the respondents answered affirmatively. Especially, the bigger the size of the employees is, the more the percentage of enterprises working on these activities is. The result also suggested that on this point there are distinct characteristics by industries.

In the question on the fields the company is currently using research outcomes of universities and public research institutes, 70% of the respondents answered that they are using research outcomes of universities and public research institutes in one way or another. Particularly, respondents who are using research outcomes in the fields of manufacturing technology were dominant in number. It was also suggested that there are differences among industries as to what fields of research are actually being used.

In the question on the stage research outcomes of universities and public research institutes are helpful, the respondents who are making use of research outcomes to complement their own product development were dominant in number. It was also suggested that the size of the companies does not have much relation with the ways of making use of research outcomes of universities and public research institutes.

Collaboration between industry-university-government is seen as an explicit case of using research outcomes of universities and public research institutes. In the question on the ways of collaboration with universities and public research institutes

in the past ten years, the answer as “no experience” was highest in number. As the other answers, “joint research,” “contract research,” and “contributing fund” were notable in that order.

As the percentage of products or services that had not been created without research outcomes of universities and public research institutes, “nothing” was highest in number. The responses that all of the products or services were produced by utilizing research outcomes of universities and public research institutes were extremely low in percentage.

We obtained a similar result to the one above, for the question on the extent of contribution of research outcomes of universities and public research institutes, to sales of the company.

As for the question on the length of time required to complete products that could not be created without research outcomes of universities and public research institutes, after introducing them or starting collaboration with universities and public research institutes, the alternative “2 years or longer and less than 4 years” was highest in number. This result suggests that the duration for bringing about commercialization of a product by utilizing research outcomes of universities and public research institutes is neither extremely long nor short.

Surely the knowledge we can obtain from this survey is not limited to what we have described above. We are continuing our efforts to investigate more using the data obtained.

Acknowledgement

This study was carried out within the contract research project (from April 2006 to March 2009) from RIKEN. Note that views in this paper do not represent those of RIKEN. Authors thank Professor Jun Suzuki of GRIPS for his advice in construction of survey. All the errors that might be occurred in this paper are attributed to the authors.

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Table1 Descriptive Statistics（Base attribute）

Variables	Definion	sample	mean	S.D.	min	max
10 areas dummy						
hokkaido	1 if a respondent's central office is located in hokkaido, 0 otherwise.	10731	0.054	0.225	0	1
tohoku	1 if a respondent's central office is located in tohoku (Aomori, Iwate, Miyagi, Akita, Yamagata, Fukushima), 0 otherwise.	10731	0.064	0.244	0	1
kita_kanto	1 if a respondent's central office is located in kita_kanto (Ibaragi, Tochigi, Gunma, Yamanashi, Nagano), 0 otherwise.	10731	0.061	0.240	0	1
minami_kanto	1 if a respondent's central office is located in minami_kanto (Saitama, Chiba, Tokyo, Kanagawa), 0 otherwise.	10731	0.340	0.474	0	1
hokuriku	1 if a respondent's central office is located in hokuriku (Niigata, Toyama, Ishikawa, Fukui), 0 otherwise.	10731	0.047	0.211	0	1
tokai	1 if a respondent's central office is located in tokai (Gifu, Shizuoka, Aichi, Mie), 0 otherwise.	10731	0.107	0.310	0	1
kinki	1 if a respondent's central office is located in kinki (Shiga, Kyoto, Osaka, Hyogo, Nara, Wakayama), 0 otherwise.	10731	0.163	0.369	0	1
chugoku	1 if a respondent's central office is located in chugoku (Tottori, Shimane, Okayama, Hiroshima, Yamaguchi), 0 otherwise.	10731	0.062	0.241	0	1
shikoku	1 if a respondent's central office is located in shikoku (Tokushima, Kagawa, Ehime, Kochi), 0 otherwise.	10731	0.031	0.173	0	1
kyushu	1 if a respondent's central office is located in kyushu (Fukuoka, Saga, Nagasaki, Kumamoto, Ooita, Miyazaki, Kagoshima, Okinawa), 0 otherwise.	10731	0.072	0.259	0	1
Prefecture dummy						
hokkaido	1 if a respondent's central office is located in hokkaido, 0 otherwise.	10731	0.054	0.225	0	1
aomori	1 if a respondent's central office is located in aomori, 0 otherwise.	10731	0.008	0.092	0	1
iwate	1 if a respondent's central office is located in iwate, 0 otherwise.	10731	0.007	0.081	0	1
miyagi	1 if a respondent's central office is located in miyagi, 0 otherwise.	10731	0.016	0.127	0	1
akita	1 if a respondent's central office is located in akita, 0 otherwise.	10731	0.007	0.083	0	1
yamagata	1 if a respondent's central office is located in yamagata, 0 otherwise.	10731	0.010	0.102	0	1
fuhukushima	1 if a respondent's central office is located in fukushima, 0 otherwise.	10731	0.015	0.120	0	1
ibaragi	1 if a respondent's central office is located in ibaragi, 0 otherwise.	10731	0.015	0.122	0	1
tochigi	1 if a respondent's central office is located in tochigi, 0 otherwise.	10731	0.010	0.099	0	1
gunma	1 if a respondent's central office is located in gunma, 0 otherwise.	10731	0.011	0.106	0	1
yamanashi	1 if a respondent's central office is located in yamanashi, 0 otherwise.	10731	0.006	0.076	0	1
nagano	1 if a respondent's central office is located in nagano, 0 otherwise.	10731	0.019	0.136	0	1
saitama	1 if a respondent 's central office is located in saitama, 0 otherwise.	10731	0.036	0.186	0	1
chiba	1 if a respondent's central office is located in chiba, 0 otherwise.	10731	0.020	0.141	0	1
tokyo	1 if a respondent's central office is located in tokyo, 0 otherwise.	10731	0.240	0.427	0	1
kanagawa	1 if a respondent's central office is located in kanagawa, 0 otherwise.	10731	0.044	0.205	0	1
niigata	1 if a respondent's central office is located in niigata, 0 otherwise.	10731	0.023	0.149	0	1
toyama	1 if a respondent's central office is located in toyama, 0 otherwise.	10731	0.009	0.094	0	1
ishikawa	1 if a respondent's central office is located ishikawa, 0 otherwise.	10731	0.008	0.091	0	1
fukui	1 if a respondent's central office is located in fukui, 0 otherwise.	10731	0.007	0.082	0	1
gifu	1 if a respondent's central office is located in gifu, 0 otherwise.	10731	0.012	0.108	0	1
shizuoka	1 if a respondent's central office is located in shizuoka, 0 otherwise.	10731	0.024	0.153	0	1
aichi	1 if a respondent's central office is located in aichi, 0 otherwise.	10731	0.059	0.236	0	1
mie	1 if a respondent's central office is located in mie, 0 otherwise.	10731	0.012	0.111	0	1
shiga	1 if a respondent's central office is located in shiga, 0 otherwise.	10731	0.008	0.090	0	1
kyoto	1 if a respondent 's central office is located in kyoto, 0 otherwise.	10731	0.019	0.136	0	1
osaka	1 if a respondent's central office is located in osaka, 0 otherwise.	10731	0.096	0.295	0	1
hyogo	1 if a respondent's central office is located in hyogo, 0 otherwise.	10731	0.031	0.173	0	1
nara	1 if a respondent's central office is located in nara, 0 otherwise.	10731	0.005	0.073	0	1
wakayama	1 if a respondent's central office is located in wakayama , 0 otherwise.	10731	0.003	0.054	0	1
tottori	1 if a respondent's central office is located in tottori, 0 otherwise.	10731	0.005	0.069	0	1
shimane	1 if a respondent's central office is located in shimane, 0 otherwise.	10731	0.004	0.063	0	1
okayama	1 if a respondent's central office is located in okayama, 0 otherwise.	10731	0.015	0.122	0	1
hiroshima	1 if a respondent's central office is located in hiroshima, 0 otherwise.	10731	0.028	0.164	0	1
yamaguchi	1 if a respondent's central office is located in yamaguchi, 0 otherwise.	10731	0.011	0.102	0	1
tokushima	1 if a respondent's central office is located in tokushima, 0 otherwise.	10731	0.005	0.071	0	1
kagawa	1 if a respondent's central office is located in kagawa, 0 otherwise.	10731	0.012	0.107	0	1
ehime	1 if a respondent's central office is located in ehime , 0 otherwise.	10731	0.009	0.096	0	1
kochi	1 if a respondent's central office is located in kochi, 0 otherwise.	10731	0.005	0.069	0	1

continued

fukuoka	1 if a respondent's central office is located in fukuoka, 0 otherwise.	10731	0.032	0.175	0	1
saga	1 if a respondent's central office is located in saga, 0 otherwise.	10731	0.005	0.073	0	1
nagasaki	1 if a respondent's central office is located in nagasaki, 0 otherwise.	10731	0.007	0.082	0	1
kumamoto	1 if a respondent's central office is located in kumamoto, 0 otherwise.	10731	0.007	0.085	0	1
oita	1 if a respondent's central office is located in oita, 0 otherwise.	10731	0.006	0.075	0	1
miyazaki	1 if a respondent's central office is located in miyazaki, 0 otherwise.	10731	0.004	0.062	0	1
kagoshima	1 if a respondent's central office is located in kagoshima, 0 otherwise.	10731	0.008	0.090	0	1
okinawa	1 if a respondent's central office is located in okinawa, 0 otherwise.	10731	0.004	0.060	0	1
Firm size						
Employee	Number of employee	10672	143.399	927.01	0	67116
Big firm dummy	1 if a respondent is a large firm, 0 otherwise according to Small and Medium Enterprise Basic Law.	10670	0.098	0.298	0	1
Industry dummy						
Agriculture	1 if a respondent belongs to agriculture, forestry and fisheries, 0 otherwise.	10731	0.003	0.058	0	1
Finance	1 if a respondent belongs to finance, 0 otherwise.	10731	0.012	0.108	0	1
Building	1 if a respondent belongs to building, 0 otherwise.	10731	0.134	0.341	0	1
Real estate	1 if a respondent belongs to real estate, 0 otherwise.	10731	0.024	0.153	0	1
Manufacturing	1 if a respondent belongs to manufacturing, 0 otherwise.	10731	0.288	0.453	0	1
Wholesale	1 if a respondent belongs to wholesale, 0 otherwise.	10731	0.318	0.466	0	1
Retail	1 if a respondent belongs to retail, 0 otherwise.	10731	0.046	0.210	0	1
Traffic/Warehousing	1 if a respondent belongs to traffic or warehousing, 0 otherwise.	10731	0.036	0.187	0	1
Service	1 if a respondent belongs to service, 0 otherwise.	10731	0.136	0.343	0	1
Other	1 if a respondent belongs to other, 0 otherwise.	10731	0.002	0.048	0	1
Category of bussiness dummy						
category1	1 if a respondent belongs to agriculture, forestry and fisheries, 0 otherwise.	10731	0.003	0.058	0	1
category2	1 if a respondent belongs to finance, 0 otherwise.	10731	0.012	0.108	0	1
category3	1 if a respondent belongs to building , 0 otherwise.	10731	0.134	0.341	0	1
category4	1 if a respondent belongs to real estate, 0 otherwise.	10731	0.024	0.153	0	1
category5	1 if a respondent belongs to food and beverage industry, feed manufacturing, 0 otherwise.	10731	0.033	0.180	0	1
category6	1 if a respondent belongs to textile,clothing manufacturing, 0 otherwise.	10731	0.010	0.102	0	1
category7	1 if a respondent belongs to building material, furniture, ceramic, lime manufacturing, 0 otherwise.	10731	0.024	0.153	0	1
category8	1 if a respondent belongs to pulp, paper, paper manufacturing, 0 otherwise.	10731	0.011	0.104	0	1
category9	1 if a respondent belongs to publising, print manufacturing, 0 otherwise.	10731	0.019	0.138	0	1
category10	1 if a respondent belongs to chemical goods manufacturing, 0 otherwise.	10731	0.039	0.193	0	1
category11	1 if a respondent belongs to steel, nonferrous, mining manufacturing, 0 otherwise.	10731	0.047	0.212	0	1
category12	1 if a respondent belongs to machinery manufacturing, 0 otherwise.	10731	0.043	0.203	0	1
category13	1 if a respondent belongs to electrical machine manufacturing, 0 otherwise.	10731	0.035	0.184	0	1
category14	1 if a respondent belongs to transporate machine, fixings manufacturing, 0 otherwise.	10731	0.009	0.093	0	1
category15	1 if a respondent belongs to accurate instrument, medical machine, fixings manufacturing, 0 otherwise.	10731	0.007	0.085	0	1
category16	1 if a respondent belongs to other manufacturing	10731	0.010	0.098	0	1
category17	1 if a respondent belongs to food and beverage industry, feed wholesale, 0 otherwise.	10731	0.037	0.188	0	1
category18	1 if a respondent belongs to textile, clothing wholesale, 0 otherwise.	10731	0.021	0.144	0	1
category19	1 if a respondent belongs to building material, furniture, ceramic, lime wholesale, 0 otherwise.	10731	0.041	0.198	0	1
category20	1 if a respondent belongs to paper,stationary, book wholesale, 0 otherwise.	10731	0.011	0.106	0	1
category21	1 if a respondent belongs to chemical goods wholesale, 0 otherwise.	10731	0.029	0.168	0	1
category22	1 if a respondent belongs to recycler wholesale, 0 otherwise.	10731	0.002	0.043	0	1
category23	1 if a respondent belongs to steel, nonferrous, mining wholesale, 0 otherwise.	10731	0.035	0.184	0	1
category24	1 if a respondent belongs to machinary, fixings wholesale, 0 otherwise.	10731	0.102	0.303	0	1
category25	1 if a respondent belongs to other wholesale, 0 otherwise.	10731	0.040	0.195	0	1

continued

category26	1 if a respondent belongs to food and beverage retailing, 0 otherwise.	10731	0.007	0.085	0	1
category27	1 if a respondent belongs to textile,clothing retailing, 0 otherwise.	10731	0.004	0.060	0	1
category28	1 if a respondent belongs to drug and convenience goods retailing, 0 otherwise.	10731	0.003	0.051	0	1
category29	1 if a respondent belongs to furniture retailing, 0 otherwise.	10731	0.001	0.035	0	1
category30	1 if a respondent belongs to HE and Info-telecom device retailing, 0 otherwise.	10731	0.005	0.070	0	1
category31	1 if a respondent belongs to car and parts retailing, 0 otherwise.	10731	0.005	0.072	0	1
category32	1 if a respondent belongs to professional goods retailing, 0 otherwise.	10731	0.014	0.119	0	1
category33	1 if a respondent belongs to various goods retailing, 0 otherwise.	10731	0.006	0.079	0	1
category34	1 if a respondent belongs to other retailing, 0 otherwise.	10731	0.001	0.024	0	1
category35	1 if a respondent belongs to transportation and warehouse, 0 otherwise.	10731	0.036	0.187	0	1
category36	1 if a respondent belongs to service (restaurant), 0 otherwise.	10731	0.003	0.056	0	1
category37	1 if a respondent belongs to service (mail and telecom), 0 otherwise.	10731	0.001	0.036	0	1
category38	1 if a respondent belongs to service (electricity, gas, water service, heat supply), 0 otherwise.	10731	0.001	0.029	0	1
category39	1 if a respondent belongs to service (lease, rental), 0 otherwise.	10731	0.014	0.119	0	1
category40	1 if a respondent belongs to service (hotel), 0 otherwise.	10731	0.004	0.062	0	1
category41	1 if a respondent belongs to service (amusement), 0 otherwise.	10731	0.005	0.072	0	1
category42	1 if a respondent belongs to service (broadcast), 0 otherwise.	10731	0.002	0.040	0	1
category43	1 if a respondent belongs to service (maintenance, security, inspection), 0 otherwise.	10731	0.013	0.115	0	1
category44	1 if a respondent belongs to service (ad), 0 otherwise.	10731	0.014	0.119	0	1
category45	1 if a respondent belongs to service (information service), 0 otherwise.	10731	0.035	0.183	0	1
category46	1 if a respondent belongs to service(manpower dispatching, recruting), 0 otherwise.	10731	0.004	0.063	0	1
category47	1 if a respondent belongs to service(professional services), 0 otherwise.	10731	0.019	0.135	0	1
category48	1 if a respondent belongs to service (medical, welfare, health services), 0 otherwise.	10731	0.008	0.088	0	1
category49	1 if a respondent belongs to service (education service), 0 otherwise.	10731	0.002	0.040	0	1
category50	1 if a respondent belongs to service (other service), 0 otherwise.	10731	0.011	0.106	0	1
category51	1 if a respondent belongs to other, 0 otherwise.	10731	0.002	0.048	0	1

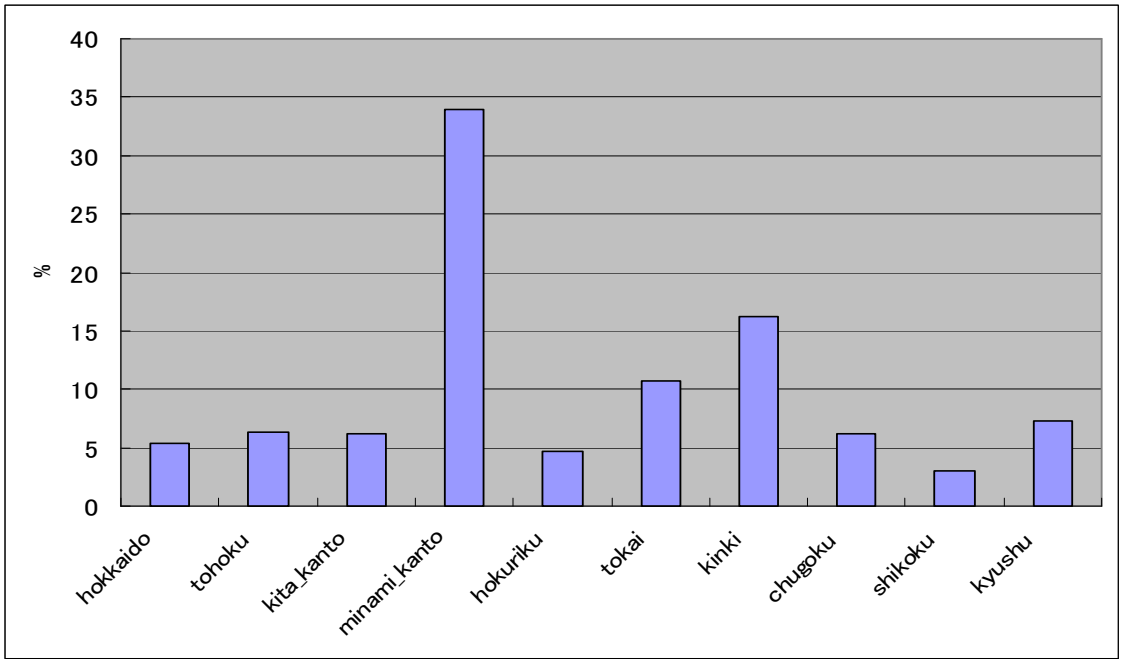


Figure 1 The percentage of respondents by the central office's location (10 areas) in GRIPS survey

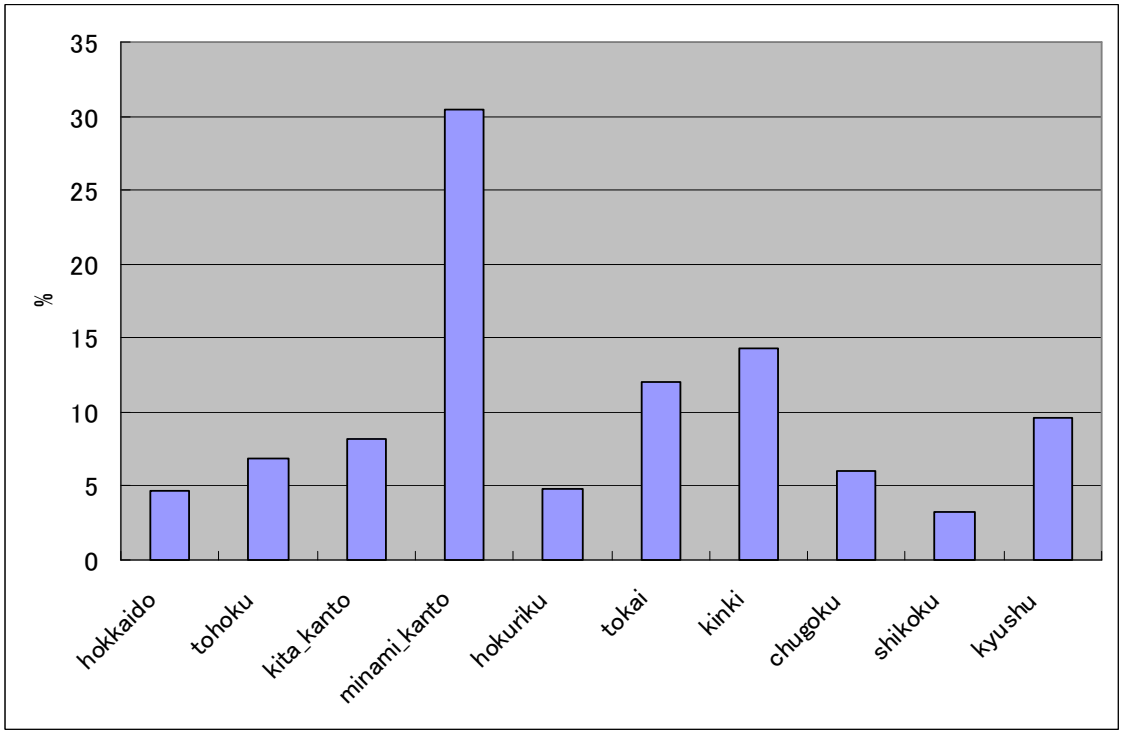


Figure 2 The percentage of respondents by the central office's location (10 areas) in "Establishment and Enterprise Census" by the MIC

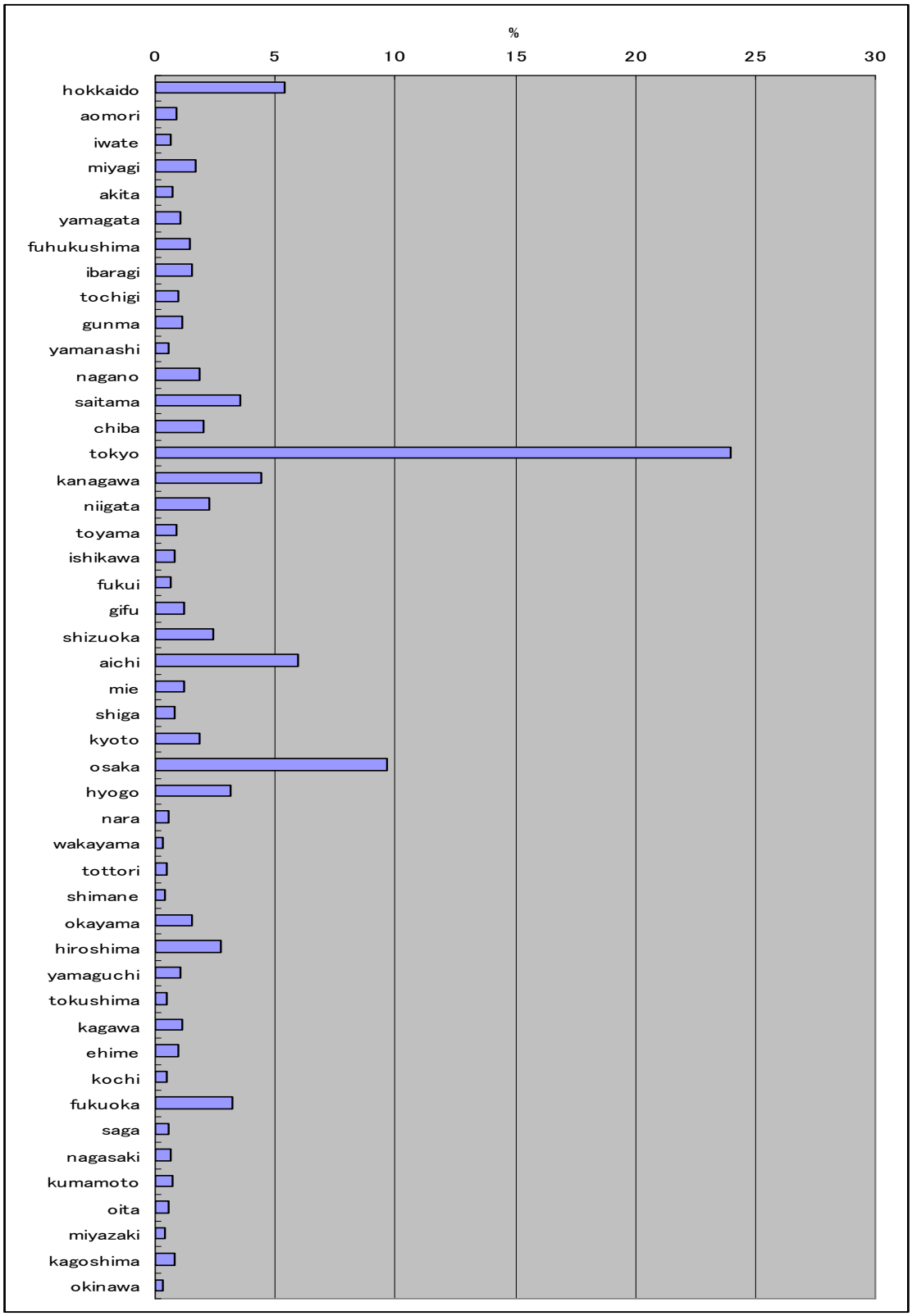


Figure 3 The percentage of respondents by the central office's location (prefectures) in GRIPS survey

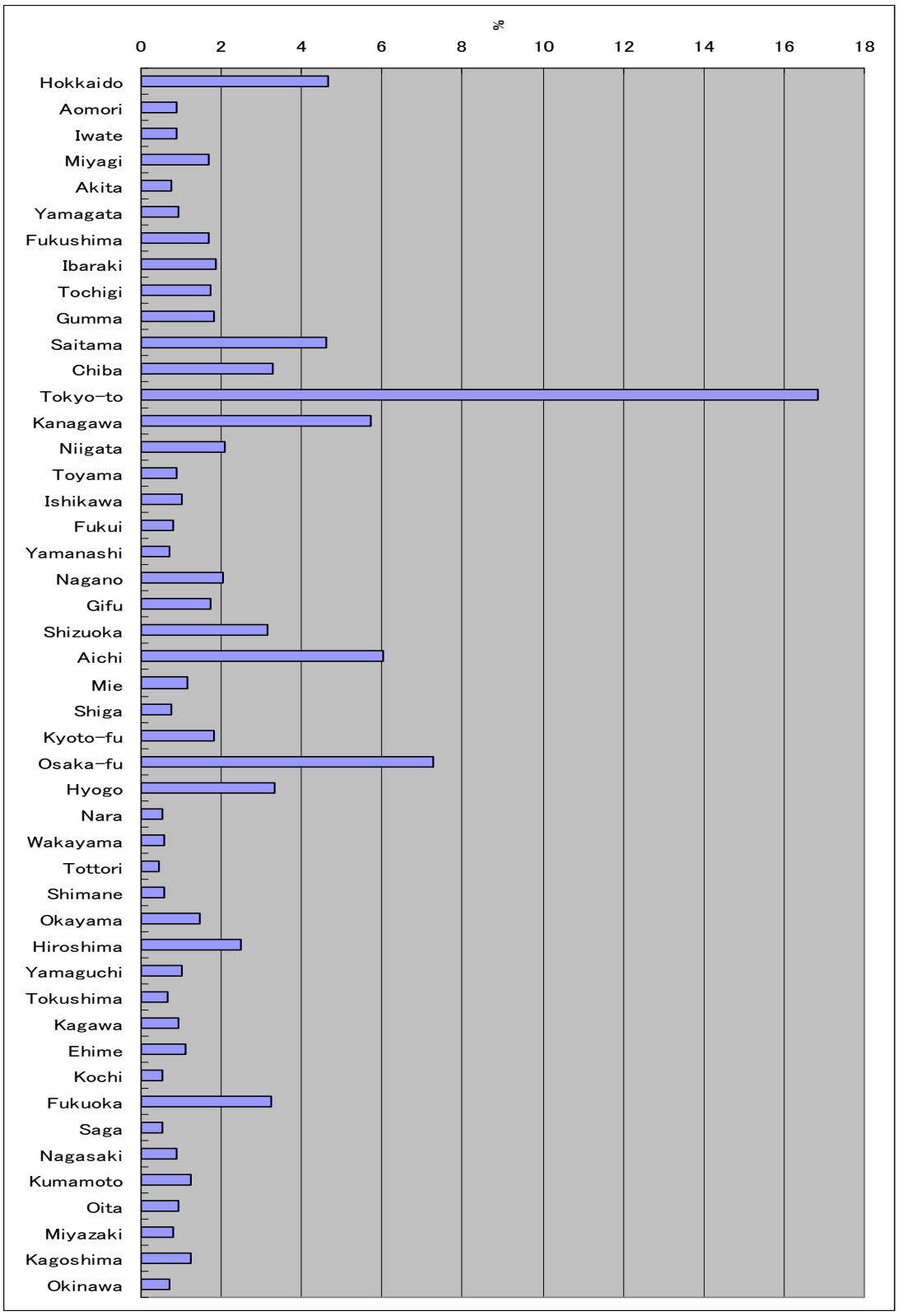


Figure 4 The percentage of respondents by the central office's location (prefectures) in "Establishment and Enterprise Census" by the MIC

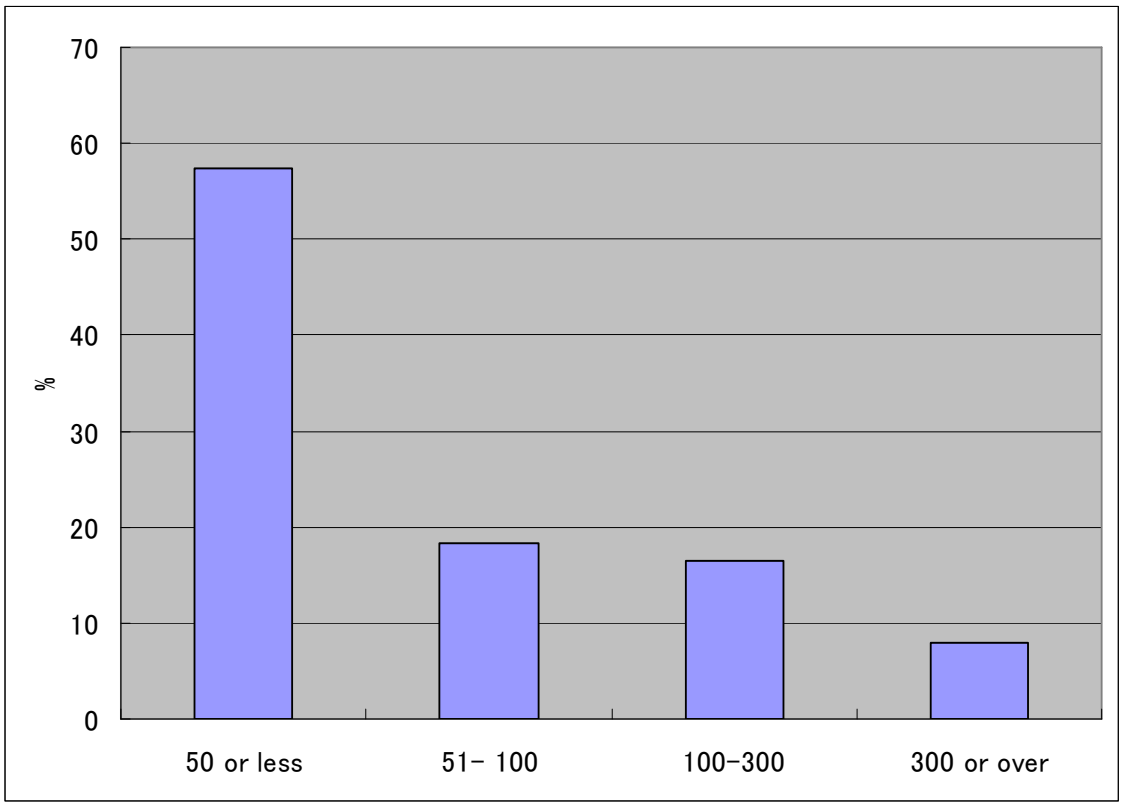


Figure 5 The percentage of respondents by size of employee in GRIPS survey

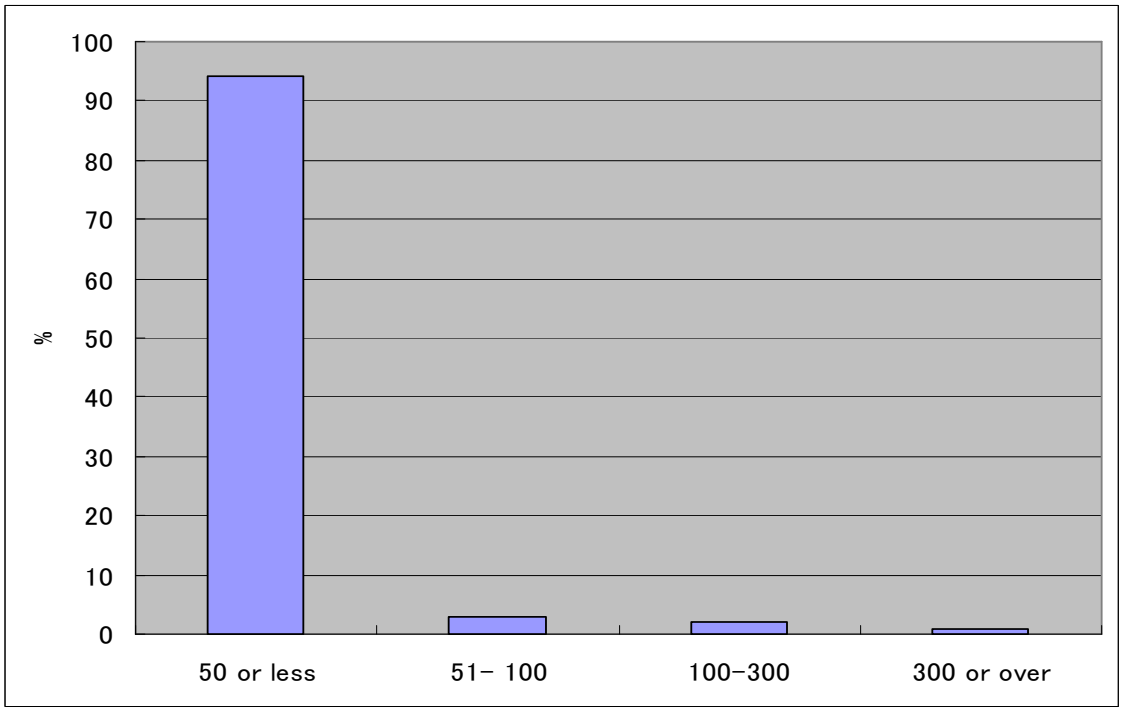


Figure 6 The percentage of respondents by size of employee in "Establishment and Enterprise Census" by the MIC

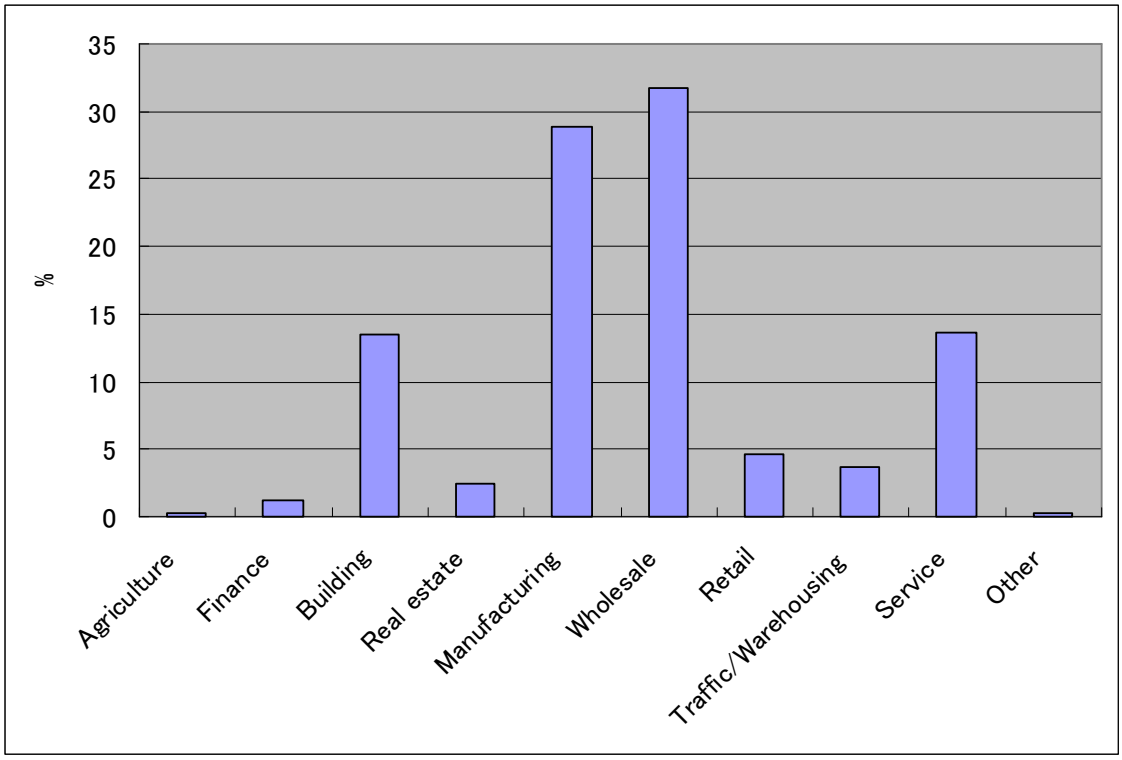


Figure 7 The percentage of respondents by industry in GRIPS survey

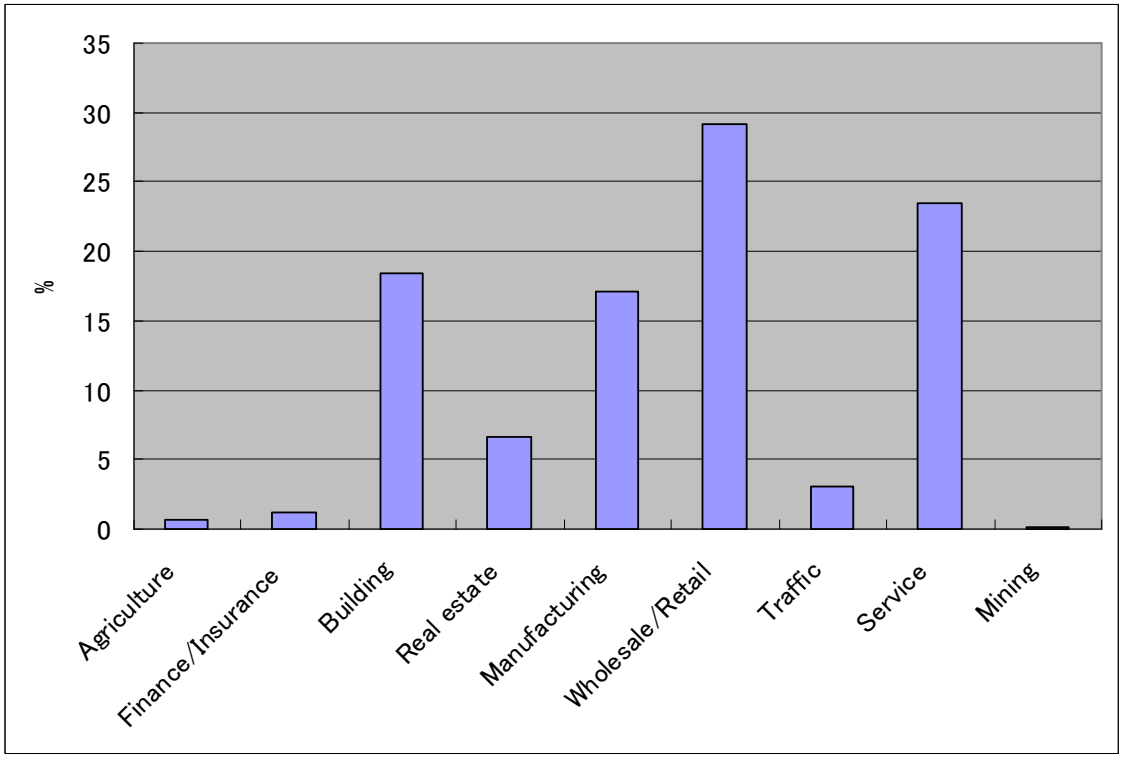


Figure 8 The percentage of respondents by industry in "Establishment and Enterprise Census" by MIC

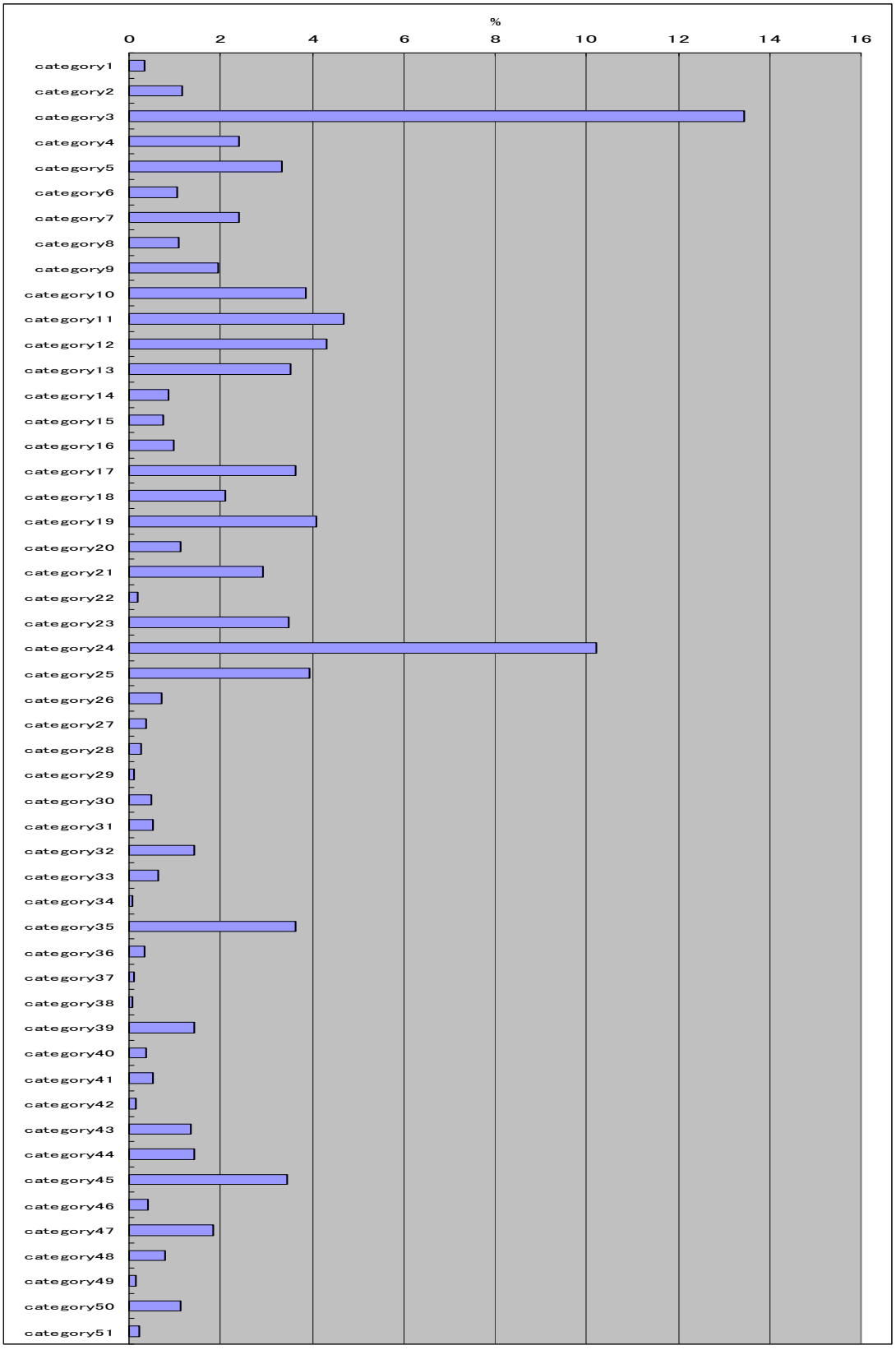


Figure 9 The percentage of respondents by category of business in GRIPS survey

Table 2 Contents of the survey sheet (The actual suevey sheet was in Japanese.)

6. The purpose of the following questions is to survey how research outcomes of universities and public research institutes are used by companies, and we conduct this survey based on the consignment from National Graduate Institute for Policy Studies and Economic and Industrial Research Office in the House of Representatives. The details of your answers will be processed statistically. None of your individual data will be released in public.

1) This question is about your company's actions concerning research and development as well as introduction of technology. Read each item and answer the item that corresponds to the situation in your company (multiple answers are welcome).

○	(a) Currently we are conducting in-house research and development.
○	(b) In the past we conducted in-house research and development. However, currently we are not doing this.
○	(c) Currently, we are introducing external research outcomes.
○	(d) In the past we introduced external research outcomes. However, currently we are not doing this.
○	(e) In the past we used in-house research outcomes or external research outcomes in the sales of our products, production method, and services in one way or another.
○	(e) In the past we used in-house research outcomes or external research outcomes in our business in one way or another. However, this use is outside the sales of our products, production method, and services.
○	(g) We neither conducted in-house research and development nor did we introduce external research outcomes.

In the Question 1 above, if you choose (a) to (f), please answer the following questions.
Note: Universities and public research institutes seen in the following mean national and public universities, private universities as well as research institutes such as national, public research institutes, independent administrative entities, and incorporated foundations. Major such institutes are National Institute of Advanced Industrial Science and Technology, RIKEN, or industrial research institutes that conduct basic research.

2) Which research outcomes in which fields are you using for your business among research outcomes of universities and public research institutes? (Multiple Answers are welcome).

○	Lifescience/bio
○	Information and telecommunication
○	Environment
○	Nanotechnology/material
○	Energy (nuclear energy, energy conservation, oil alternative energy)
○	Manufacturing technology (making various items)
○	Infrastructure (anti-disaster measures, communication/transport system)
○	Frontier (Space, Ocean)
○	Humanities/social science
○	Field not listed above
○	Nothing to help

3) At which stage did research outcomes of universities and public research institutes become helpful? (Plural answers are welcome)

○	To substitute for in-house basic research (outsourcing)
○	To complement in-house basic research
○	To complement a new product, production method, for having ideas for service, planning stage
○	To complement a new product, production method and service at the developing stage
○	For receiving hints to solve problems your company has in technology
○	To have theory for your technology, which is solely empirical
○	To verify the effectiveness of your technology
○	To verify the direction of the technology to develop in that particular field
○	To enlighten, broaden perspective, and inspire people in charge of research and development in your company
○	To obtain information that may give you a way to enter a new field of business
○	To receive hints that enable us to circumvent other company's technology
○	To complement sales promotion of your products
○	To complement building of your reputation and brand
○	Other

○	Nothing to help

4) In the past 10 years, did your company participate in collaboration in the form described below? (Plural answers are welcome.)

○	Joint research with universities and public research institutes
○	Consignment of research to universities and public research institutes
○	Sending and receiving researchers between your company and universities/ public research institutes (interns are excluded)
○	Contributing fund to universities and public research institutes to support research
○	Technology transfer from universities and public research institutes to your company (with patent right and license agreement for know-how)
○	Technology transfer from universities and public research institutes to your company (without patent right and license agreement, like technical guidance)
○	participation in the venture business that started from a university (provided human resources, capital, and technology)
○	Exchange of research sample (material)
○	Other
○	No experience

5) How many products in your company's products and services could not be created without research outcomes of universities and public research institutes? Please answer in percentage.
It is not necessary to confirm the accurate numerical value. Please answer as you feel is appropriate.

○	All (100%)
○	Very large (more than 30%, less than 100%)
○	Large (more than 10%, less than 30%)
○	Moderate large (more than 3%, less than 10%)
○	More or less (More than 1%, less than 3%)
○	Small (More than 0.3%, less than 1%)
○	Very small (It is not 0%, but less than 1%)
○	Nothing (0%)

6) How much time did it take to complete your products, which you could not create

without research outcomes of universities and public research institutes after introducing them or setting up collaboration with universities and public research institutes? If you have plural products, please answer with the average. It is not necessary to confirm the accurate numerical value. Please answer as you feel is most appropriate.

○	Less than 1 year
○	1 year or longer, less than 2 years
○	2 years or longer, less than 4 years
○	4 years or longer, less than 8 years
○	8 years or longer, less than 16 years
○	More than 16 years

7) What percentage do you think that research outcomes of universities and public research institutes contribute to your sales? It is not necessary to confirm the accurate numerical value. Please answer as you feel is appropriate.

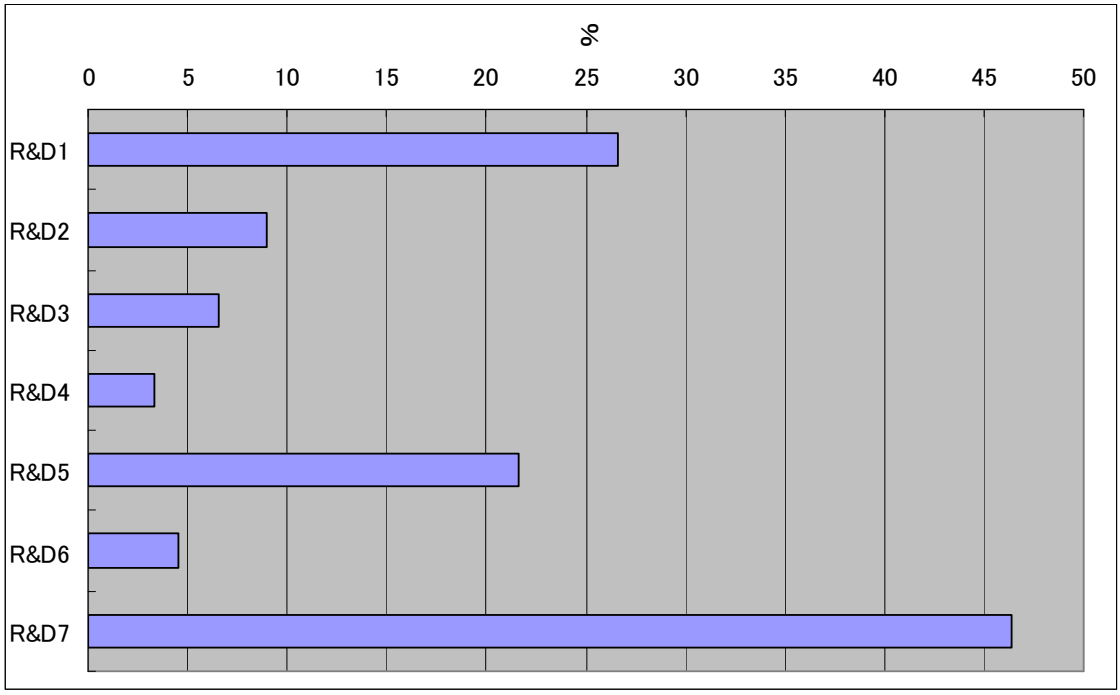
○	All (100%)
○	Very large (more than 30%, less than 100%)
○	Large (more than 10%, less than 30%)
○	Moderate large (more than 3%, less than 10%)
○	More or less (More than 1%, less than 3%)
○	Small (More than 0.3%, less than 1%)
○	Very small (It is not 0%, but less than 1%)
○	Nothing (0%)

Table 3 Descriptive Statistics (Questionnaire item)

Variables	DefinInfo-telecomion	sample	mean	S.D.	min	max
R&D1	1 if a respondent reseaches and develops in-house now, 0 otherwise	10731	0.266	0.442	0	1
R&D2	1 if a respondent had reseached and developed in-house in the past althogh he does not now, 0 otherwise	10731	0.089	0.285	0	1
R&D3	1 if a respondent introduces external research outcomes now, 0 otherwise	10731	0.066	0.248	0	1
R&D4	1 if a respondent had introduced external research outcomes in the past althogh he does not now, 0 otherwise	10731	0.033	0.180	0	1
R&D5	1 if a respondent had utilized external research outcomes for own product, process, sales of services in some form, 0 otherwise.	10731	0.216	0.412	0	1
R&D6	1 if a respondent had utilized external research outcomes for business other than own product, process, sales of services in some form, 0 otherwise.	10731	0.045	0.208	0	1
R&D7	1 if a respondent had not researched and developed by themselves and introduced external research outcomes, 0 otherwise.	10731	0.464	0.499	0	1
Life Science &Bio	1 if a respondent use the research outcomes of universities and public research institutes in Life Science &Bio for his/her business, 0 otherwise.	5360	0.070	0.256	0	1
Info-telecom	1 if a respondent use the research outcomes of universities and public research institutes in Information telecommunication for his/her business, 0 otherwise.	5360	0.110	0.313	0	1
Environment	1 if a respondent use the research outcomes of universities and public research institutes in Environment for his/her business, 0 otherwise.	5360	0.156	0.363	0	1
Nanotech/Material	1 if a respondent use the research outcomes of universities and public research institutes in Nanotech & Material for his/her business, 0 otherwise.	5360	0.082	0.274	0	1
Energy	1 if a respondent use the research outcomes of universities and public research institutes in Energy(nuclear energy, energy conservation, oil alternative energy) for his/her business, 0 otherwise.	5360	0.055	0.228	0	1
Manufacturing	1 if a respondent use the research outcomes of universities and public research institutes in Manufacturing for his/her business, 0 otherwise.	5360	0.325	0.468	0	1
Infrastructure	1 if a respondent use the research outcomes of universities and public research institutes in Infrastructure (anti-disaster measures, communication/transport system) for his/her business, 0 otherwise.	5360	0.039	0.194	0	1
Frontier	1 if a respondent use the research outcomes of universities and public research institutes in Frontier (space, ocean) for his/her business, 0 otherwise.	5360	0.004	0.059	0	1
Humanities/Social Science	1 if a respondent use the research outcomes of universities and public research institutes in Arts and Social Science for his/her business, 0 otherwise.	5360	0.009	0.095	0	1
Field not listed above	0 otherwise.	5360	0.095	0.293	0	1
Nothing to help	otherwise.	5360	0.274	0.446	0	1
process1	1 if a respondent utilized research outcomes of universities/public research institutes to substitute for in-house basic research (outsourcing) in the business, 0 otherwise.	5360	0.052	0.221	0	1
process2	1 if a respondent utilized research outcomes of universities/public research institutes to complement in-house basic research in the business, 0 otherwise.	5360	0.138	0.345	0	1
process3	1 if a respondent utilized research outcomes of universities/public research institutes to complement a new product, production method, for having ideas for service, planning stage in the business, 0 otherwise.	5360	0.124	0.330	0	1
process4	1 if a respondent utilized research outcomes of universities/public research institutes to complement a new product, production method and service at the developing stage in the business, 0 otherwise.	5360	0.151	0.358	0	1
process5	1 if a respondent utilized research outcomes of universities/public research institutes for receiving hints to solve problems your company has in technology in the business, 0 otherwise.	5360	0.108	0.310	0	1
process6	1 if a respondent utilized research outcomes of universities/public research institutes to have theory for your technology, which is solely empirical in the business, 0 otherwise.	5360	0.060	0.237	0	1
process7	1 if a respondent utilized research outcomes of universities/public research institutes to verify the effectiveness of our technology in the business, 0 otherwise.	5360	0.127	0.333	0	1
process8	1 if a respondent utilized research outcomes of universities/public research institutes to verify the direction of the technology to develop in that particular field in the business, 0 otherwise.	5360	0.064	0.244	0	1
process9	1 if a respondent utilized research outcomes of universities/public research institutes to enlighten, broaden perspective, and inspire people in charge of research and development in your company in the business, 0 otherwise.	5360	0.055	0.229	0	1
process10	1 if a respondent utilized research outcomes of universities/public research institutes to obtain information that may give us a way to enter a new field of business, 0 otherwise.	5360	0.092	0.289	0	1
process11	1 if a respondent utilized research outcomes of universities/public research institutes to receive hints that enable you to circumvent other company's technology in the business, 0 otherwise.	5360	0.021	0.142	0	1
process12	1 if a respondent utilized research outcomes of universities/public research institutes to complement sales promotion of your products in the business, 0 otherwise.	5360	0.112	0.315	0	1
process13	1 if a respondent utilized research outcomes of universities/public research institutes to complement building of our reputation and brand in the business, 0 otherwise.	5360	0.073	0.260	0	1
process14	1 if a respondent utilized research outcomes of universities/public research institutes as others than above in business in the business, 0 otherwise.	5360	0.070	0.254	0	1
process15	1 if a respondent said that there was nothing to help in research outcomes by universities/public research institutes in the business, 0 otherwise.	5360	0.330	0.470	0	1

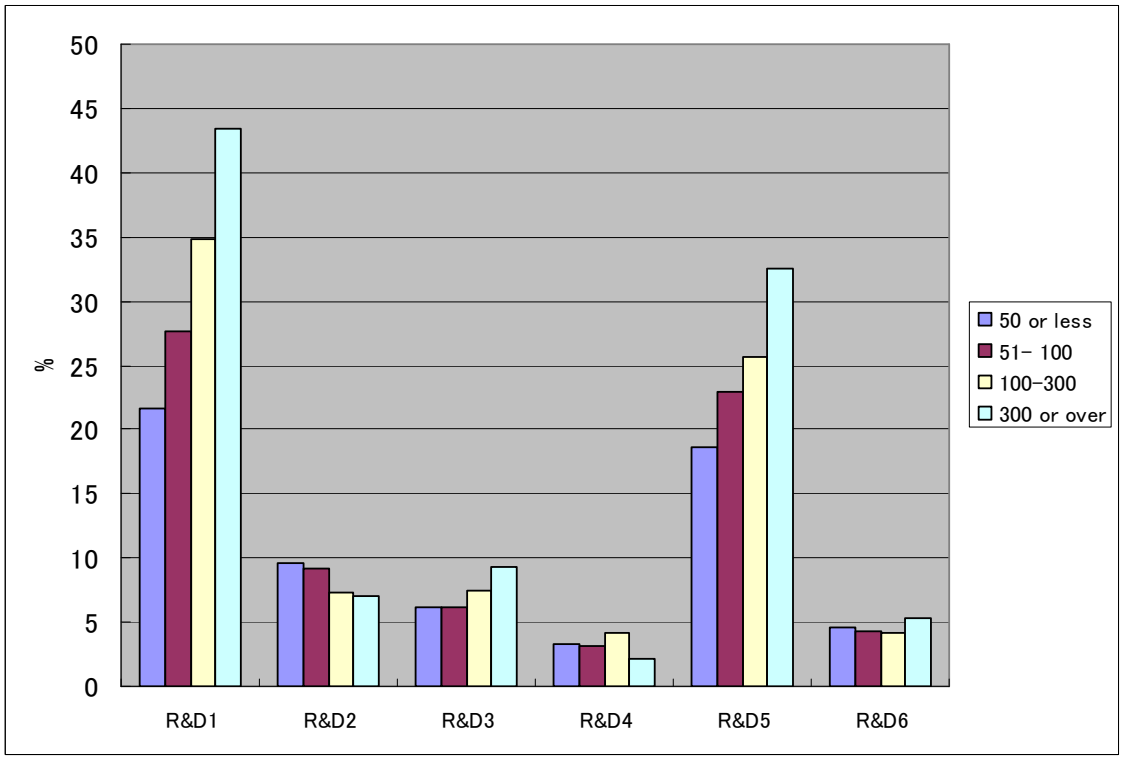
continued

collabo1	1 if a respondent has jointed research with universities and public research institutes over the last decade, 0 otherwise.	5360	0.212	0.409	0	1
collabo2	1 if a respondent has sponsored research for universities and public research institutes over the last decade, 0 otherwise.	5360	0.115	0.320	0	1
collabo3	1 if a respondent has sent and received researchers between your company and universities/ public research institutes (interns are excluded) over the last decade, 0 otherwise.	5360	0.031	0.173	0	1
collabo4	1 if a respondent has contributed fund to universities and public research institutes over the last decade, 0 otherwise.	5360	0.094	0.292	0	1
collabo5	1 if a respondent has been transferred technology from universities and public research institutes(with licence contract of patent property and know-how) over the last decade, 0 otherwise.	5360	0.025	0.156	0	1
collabo6	1 if a respondent has been transferred technology from universities and public research institutes(without licence contract of patent property and know-how,for example, technical guidance etc.) over the last decade, 0 otherwise.	5360	0.029	0.168	0	1
collabo7	1 if a respondent has participated in the venture business that started from universities (provided human resources, capital, and technology) over the last decade, 0 otherwise.	5360	0.021	0.145	0	1
collabo8	1 if a respondent has interchanged research sample (material) over the last decade, 0 otherwise.	5360	0.050	0.218	0	1
collabo9	1 if a respondent has collaborated in other ways wInfo-telecomh universities and public research institutes over the last decade, 0 otherwise.	5360	0.058	0.235	0	1
collabo10	1 if a respondent has not collaborated in any ways wInfo-telecomh universities and public research institutes over the last decade, 0 otherwise.	5360	0.556	0.497	0	1
Commercialization	Q「How many products in your company's products and services could not be created without research outcomes of universities and public research institutes? It is not necessary to confirm the accurate numerical value. Please answer as you feel is appropriate.」、8 if a respondent said all (100%), 7 if very large (more than 30% but less 100%), 6 if large (more than 10% but less than 30%), 5 if moderate large (more than 3% but less than 1%), 4 if moderate small, 3 if small (more than 0.3% but less than 1%), 2 if very small (not zero but less than 0.3%), 1 if nothing.	5173	2.481	1.738	1	8
Time-to-market	Q「How much time did it take to complete your products, which you could not create without research outcomes of universities and public research institutes after introducing them or setting up collaboration with universities and public research institutes? If you have plural products, please answer with the average. It is not necessary to confirm the accurate numerical value. Please answer as you feel is most appropriate.」, 6 if a respondent said more than 16 years, 5 if more than 8 years but less than 16 years, 4 if more than 4 years but less than 8 years, 3 if more than 2 years more than years but less than 4 years, 2 if more than a year but less than 2 years, 1 if less than a year.	3446	2.769	1.399	1	6
Sales	Q「What percentage do you think that research outcomes of universities and public research institutes contribute to your sales? It is not necessary to confirm the accurate numerical value. Please answer as you feel is appropriate.」、8 if a respondent said all (100%), 7 if very large (more than 30% but less 100%), 6 if large (more than 10% but less than 30%), 5 if moderate large (more than 3% but less than 1%), 4 if moderate small, 3 if small (more than 0.3% but less than 1%), 2 if very small (not zero but less than 0.3%), 1 if nothing.	4975	2.324	1.502	1	8



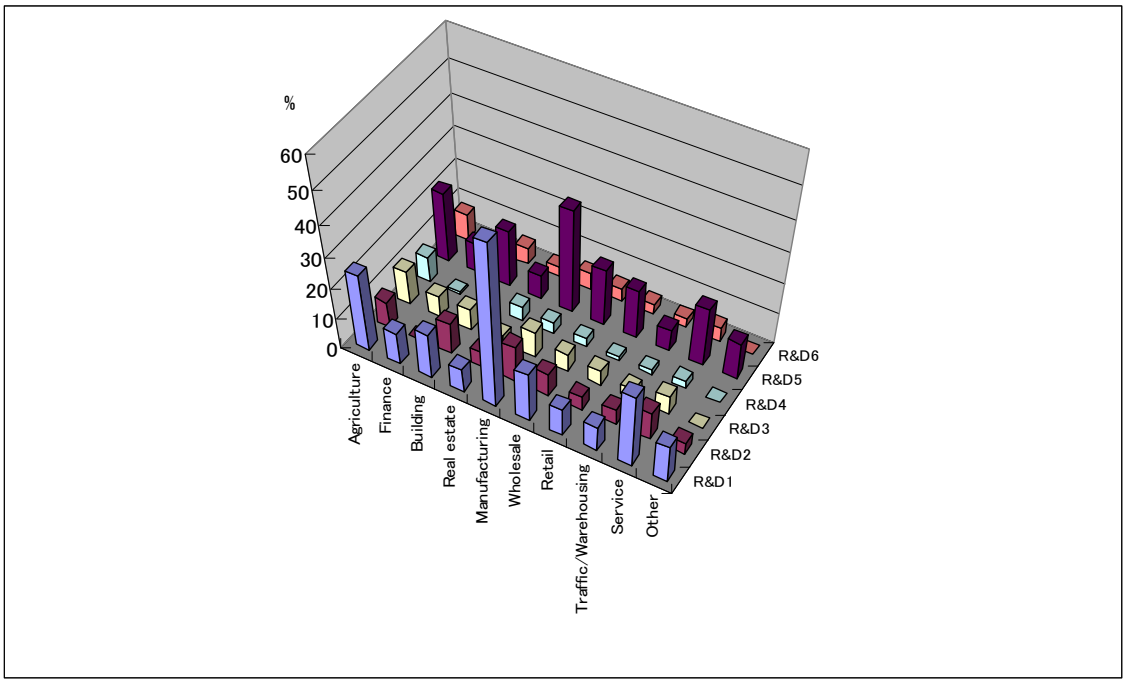
Multiple answers, N=10,731

Figure 10 Approach for R&D or technology transfer



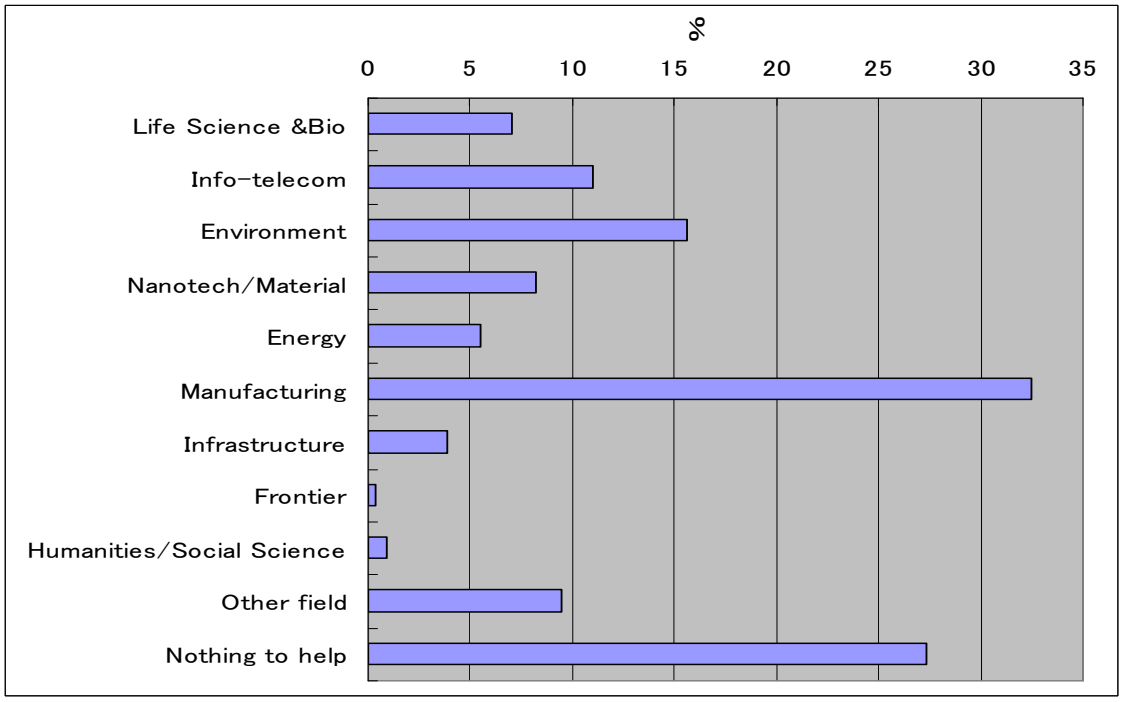
Multiple answers, N=5,748 (We excluded firms which said (g)"nothing" in Q1 of 10731)

Figure 11 Approach for R&D or technology transfer by size of employee



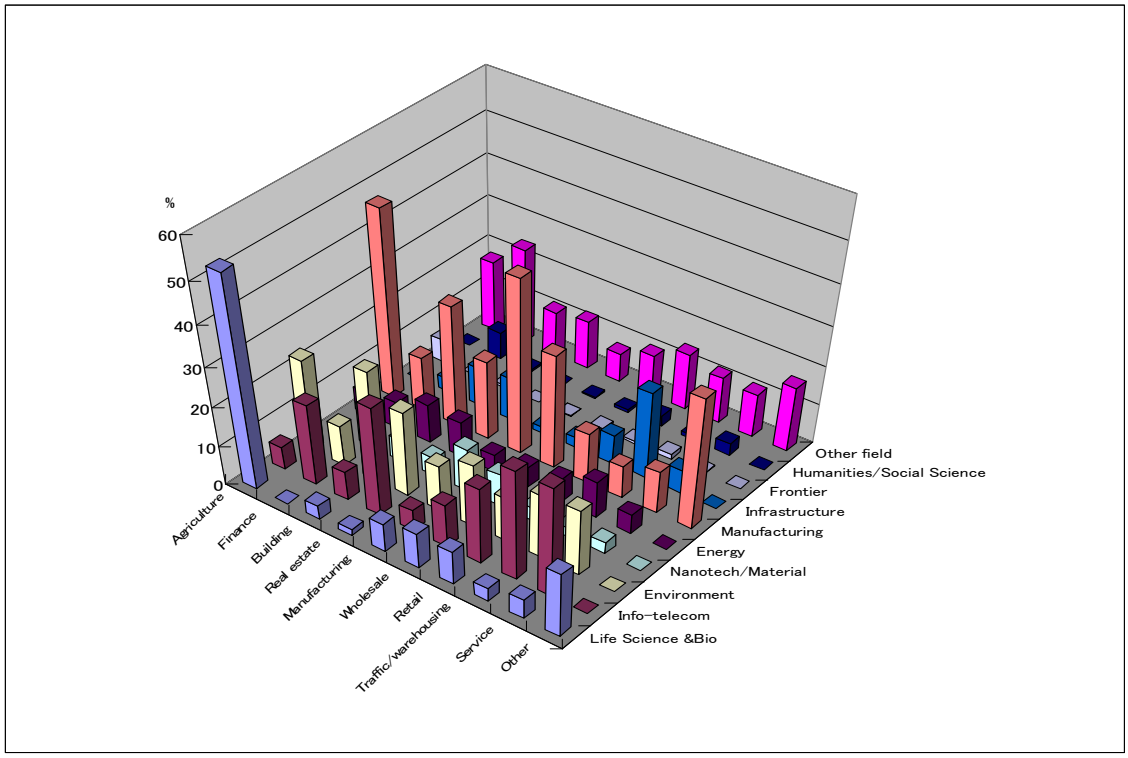
Multiple answers, N=5,748 (We excluded firms which said (g)"nothing" in Q1.)

Figure 12 Approach for R&D or technology transfer by industry



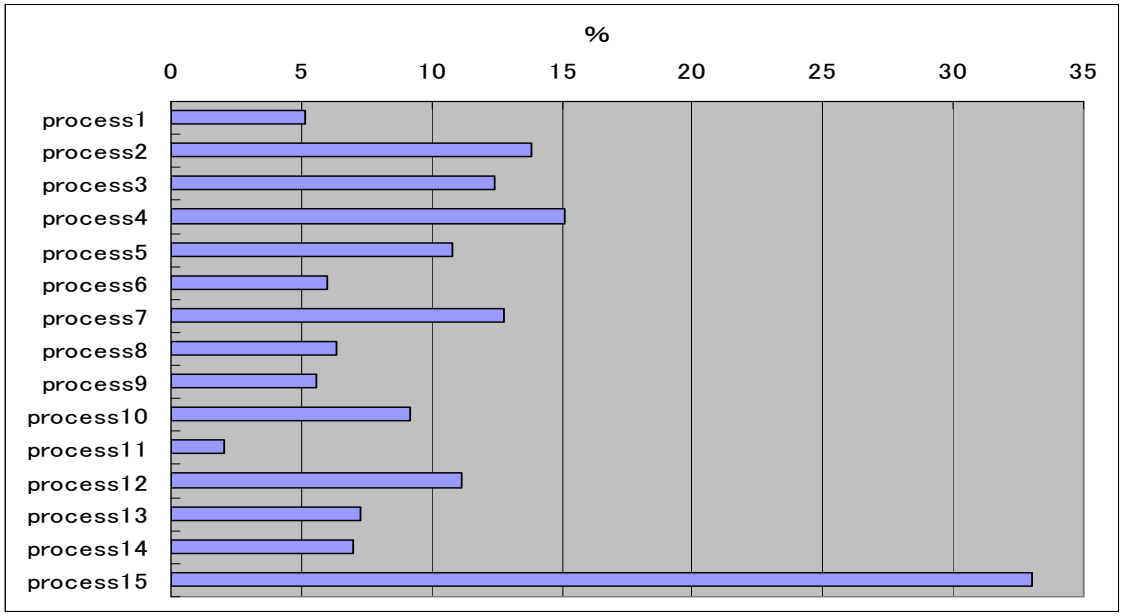
Multiple answers, N=5,360

Figure 13 Technological fields in which research outcomes of universities and public research institutes are used



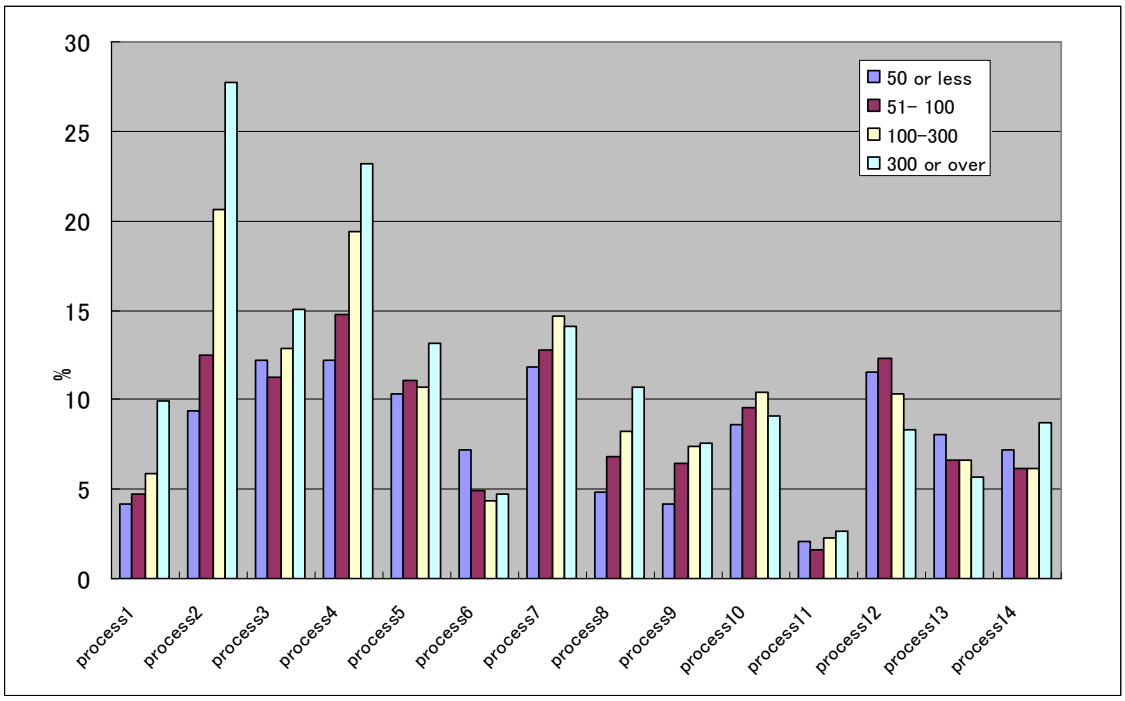
Multiple answers, N=3,894 (We excluded firms which said "nothing to help" in Q2.)

Figure 14 Technological fields in which research outcomes of universities and public research institutes are used by industry



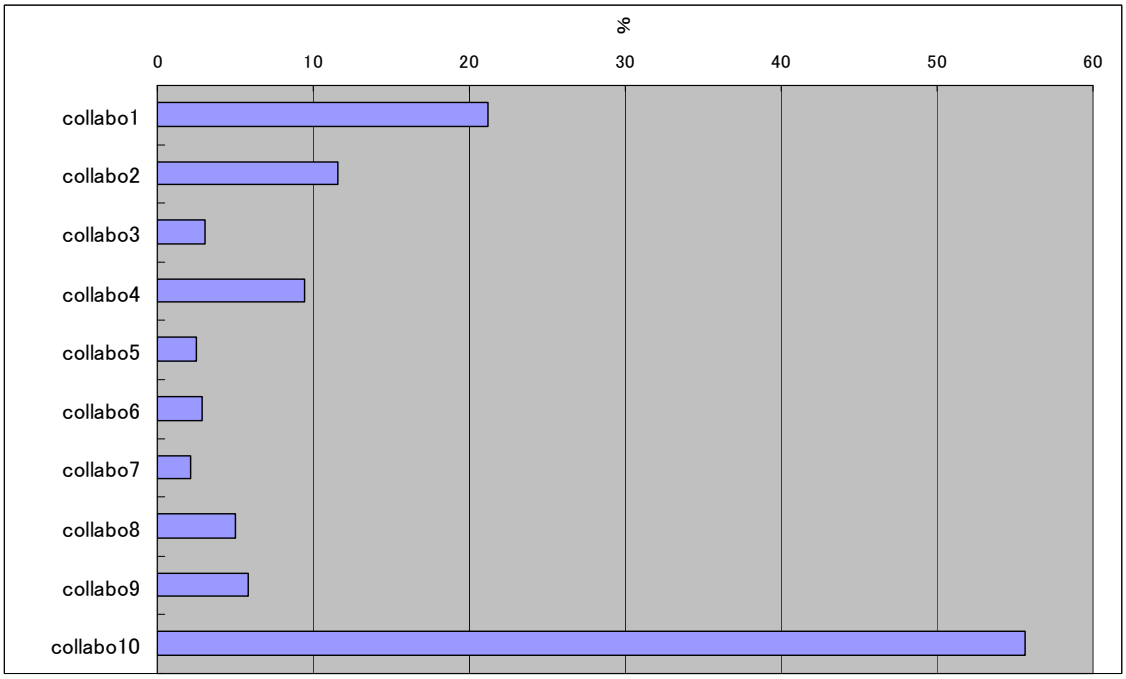
Multiple answers, N=5,360

Figure 15 Stage at which research outcomes of universities and public research institutes are helpful for firms' business



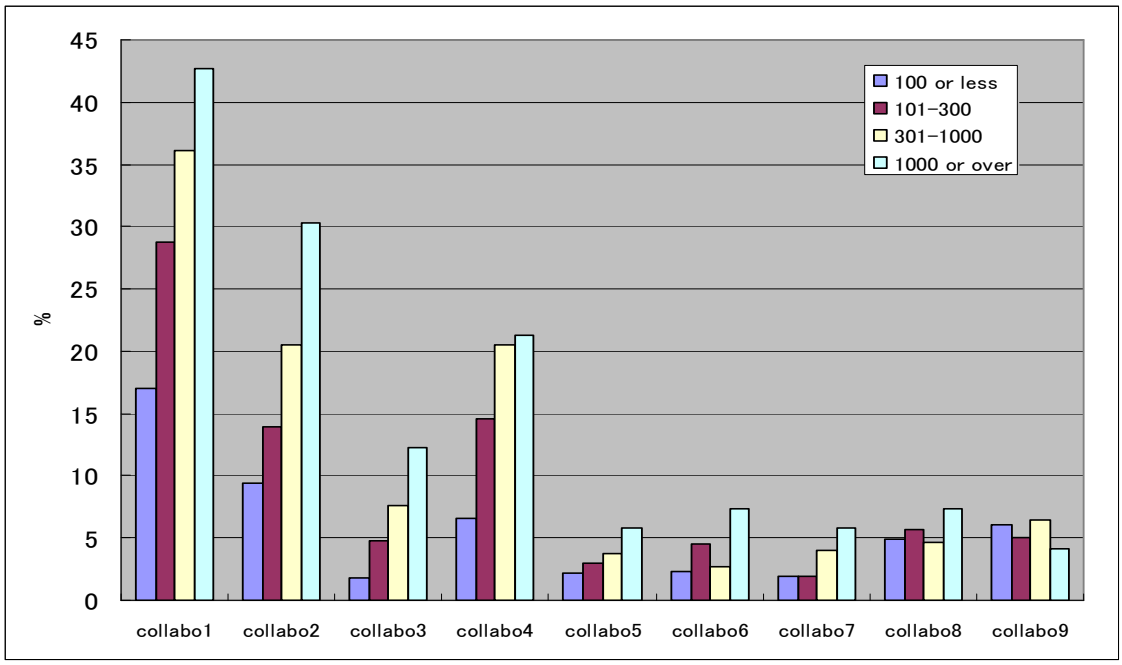
Multiple answers, N=3,560 (We excluded firms which said "nothing to help" in Q3.)

Figure 16 Stage at which research outcomes of universities and public research institutes are helpful for firms' business by size of employee



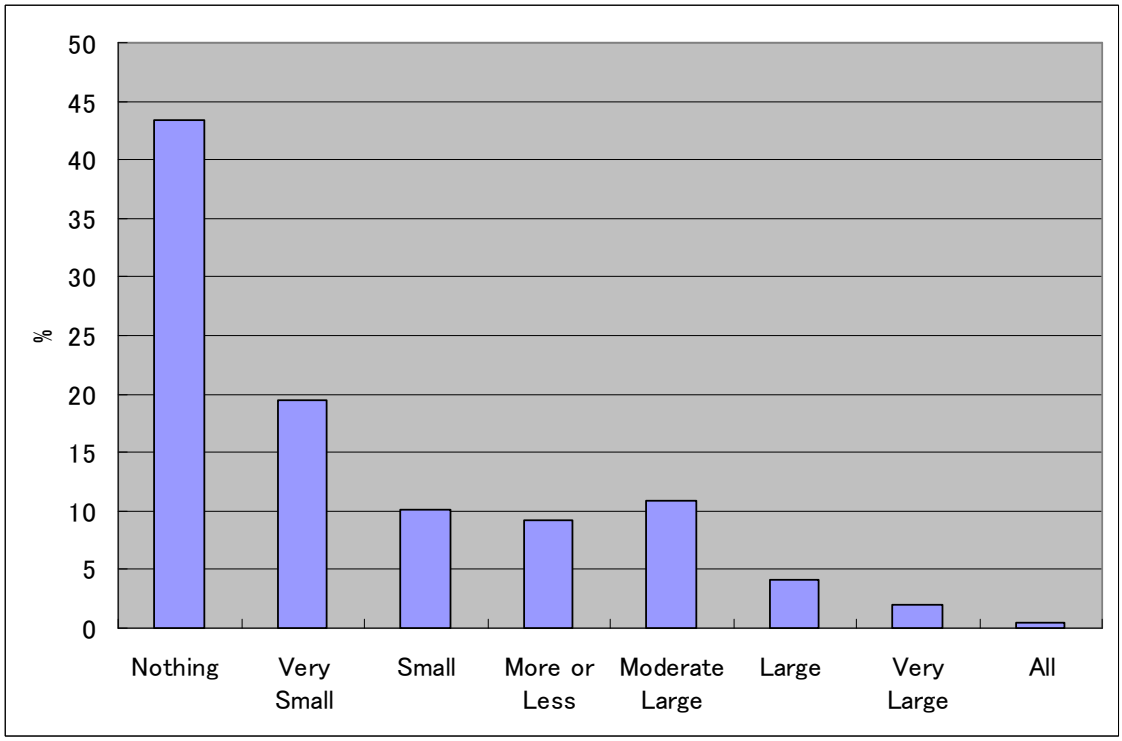
Multiple answers, N=5,360

Figure 17 Collaboration with universities and public research institutes



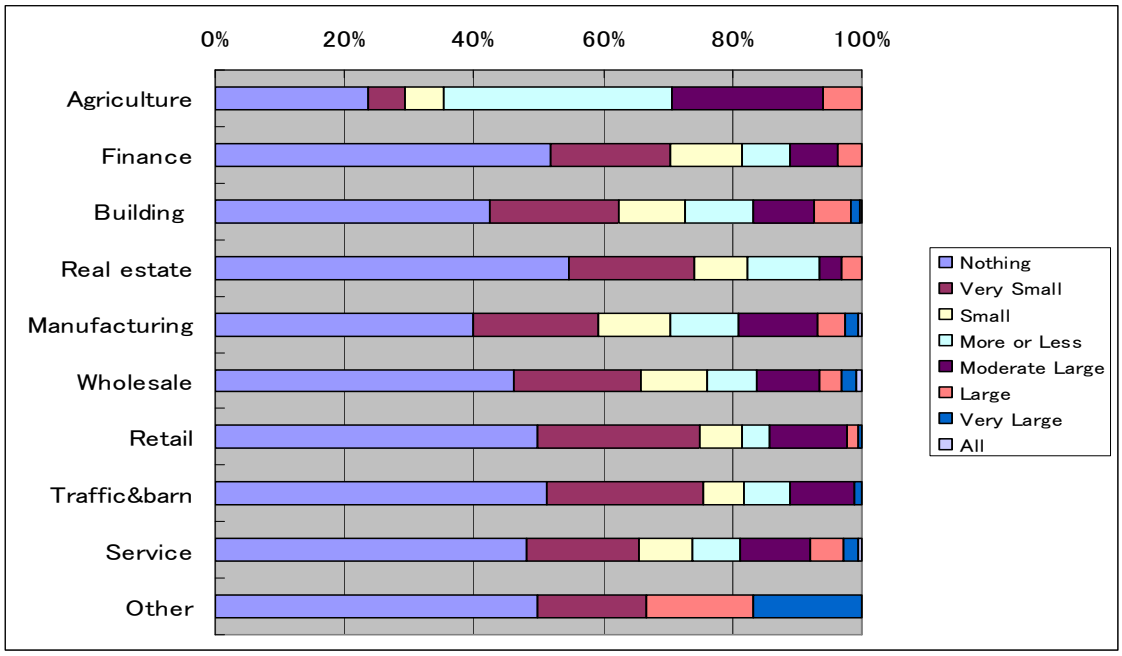
Multiple answers, N=2,378 (We excluded firms which said "we have no such experience" in Q4.)

Figure 18 Collaboration with universities and public research institutes by size of employee



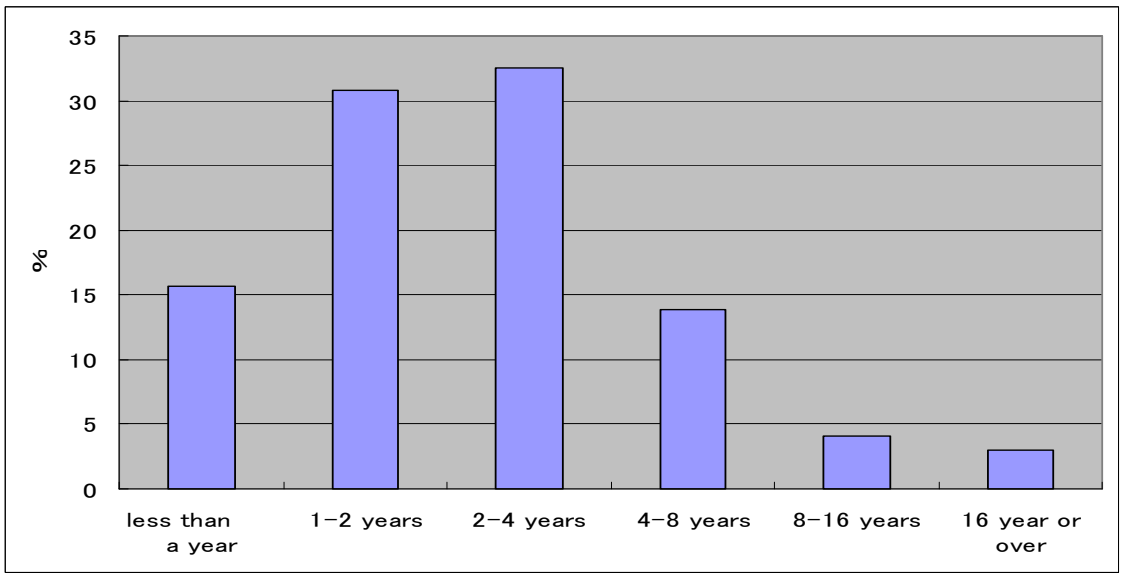
Single answer, N=5173

Figure 19 The percentage of products that could not be created without research outcomes of universities and public research institutes



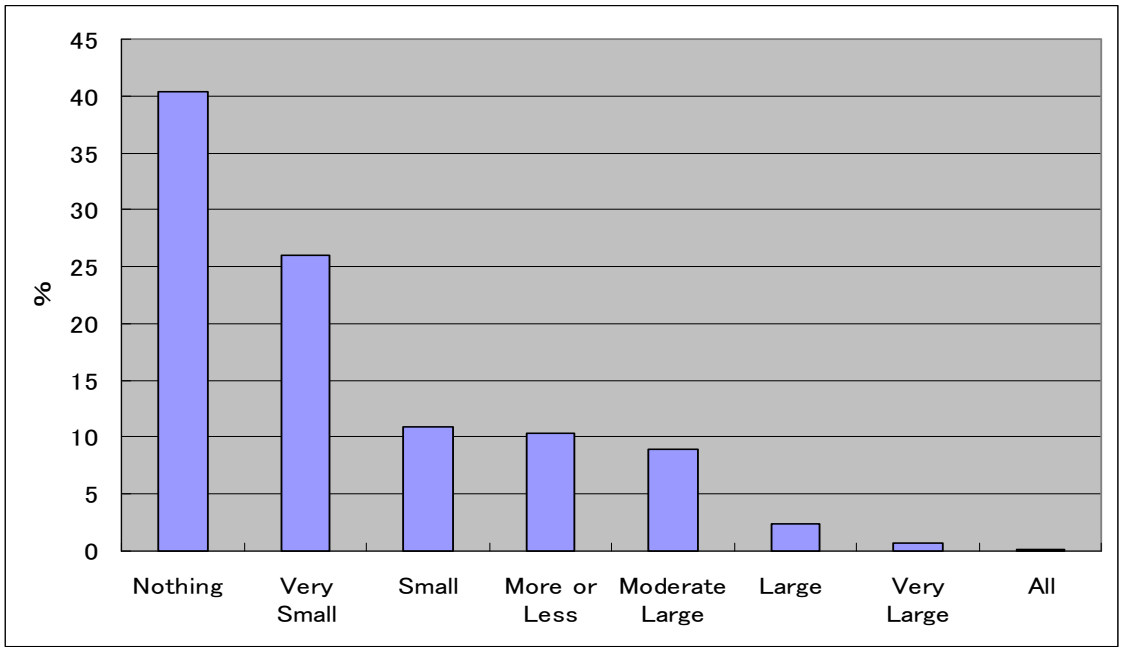
Single answer, N=5,173

Figure 20 The percentage of products that could not be created without research outcomes of universities and public research institutes by industry



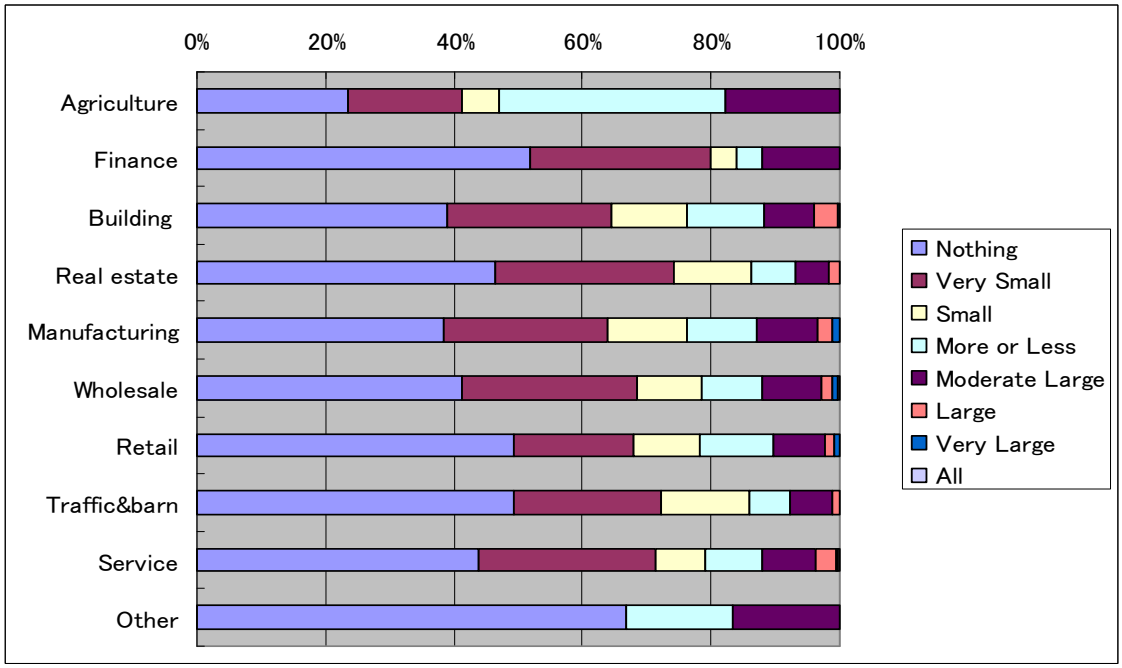
Single answer, N=2,674

Figure 21 Duration to complete your products or services which you could not produce without research outcomes of universities and public research institutes,after introducing them or starting collaboration with universities and public research institutes



Single answer, N=4,975

Figure 22 The extent to which research outcomes of universities and public research institutes contribute to sales of the company



Single answer, N=4,975

Figure 23 The extent to which research outcomes of universities and public research institutes contribute to sales of the company by industry